THE

ELECTRICAL REVIEW.

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"ELECTRICAL REVIEW."

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THE

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THE PROGRESS OF THE ELECTRICAL INDUSTRY.

THE interesting presidential address with which Mr. Robert K. Gray opened the new session of the Institution of Electrical Engineers on Thursday last week, covers so vast a field, and that so well, that our only resource in commenting thereon is to dip into the address almost at random. First, we are pleased to note that the President views with favour the suggestion which we have supported, that an alliance may possibly be formed between the leading engineering institutions, "for the erection of one large Temple of Engineering, where the various branches may find their homes," at a cost of, perhaps, a quarter of a million. The advantages to be derived from such a scheme grow more evident the more one considers them; but we need not dwell upon them here.

The President, discussing the proper functions of the Institution, urged that though for some time to come it would be necessary for that body to retain its present position as the official representative of the whole industry, it would eventually be possible for it to confine its attention to purely technical matters. We question, however, whether this would be altogether advantageous to the industry, as it is most useful for the latter to possess, in the persons of the President and Council of the Institution, official spokesmen whose authority to speak and to press forward indispensable reforms are acknowledged on all hands. The question is to some extent bound up with the preceding, for when, if ever, the Senate suggested by Mr. Gray comes into being, that body will be *par excellence* the most effective authority for purposes connected with legislation, the regulations issued by the Board of Trade and the Home Office, and similar matters.

Dealing with the state of the law relating to electricity, the President takes a broad and progressive view, pointing out how the antiquated provisions still in force, and the "parochial" ideas embodied therein, retard the development of comprehensive schemes. In his opinion, with which we heartily concur, the smaller municipalities should not be allowed by Parliament to cripple the large power schemes by refusing to take energy in bulk from the latter; inasmuch as the consumers would by this means obtain their supply at an undoubtedly cheaper rate, and the ratepayers would escape the burden of a heavy charge upon the rates in the not distant future, while the municipality, as the authorised distributor, would still retain control of the streets, it is difficult to see how any valid objection could be raised to legislation tending to bring about this result. Only the dog-in-the-manger policy of some of the municipalities, which has so often been manifested in the past, and that curious and inexplicable hatred of companies which distinguishes the average councillor, could be responsible for opposition thereto.

As for the state of the Tramways Acts—this is almost too deplorable for words; here, again, the senseless veto of the local authorities has proved obstructive in the extreme, and until this is removed, the industry will labour under heavy disadvantages. There is room for an immense development of electric traction in this country, given the opportunity.

The limits of our space prevent our commenting at length on the many interesting references to recent progress; but we cannot help expressing our disagreement with the views of the President on the adoption of the underground conduit for the L.C.C. tramways. The instances given of the rapid transmission of messages through submarine cables serve admirably to illustrate the wonderful development which has taken place in the organisation of this vast industry—one of the most important of all electrical industries, employing, as it does at the present time, almost a quarter of a million nautical miles of cable!

The President drew attention to the remarkable diversity of the chemical operations which are now being carried on by the aid of electricity, and to the great importance which this branch of industry has gradually assumed—far greater, in fact, than is commonly supposed. Finally, Mr. Gray compared the relative opportunities of students for instruction in electricity and chemistry, somewhat to the disadvantage of the latter, and warmly advocated the extension of facilities for technical education, concluding a most interesting and stimulating address with the suggestion that a London Local Section of the Institution should be formed—an admirable idea in many respects, the advantages of which are briefly set forth.

The Electrification of Fog.

When Sir Oliver Lodge was President of the Physical Society, he expressed the hope that the time of meeting would be altered from the afternoon to the evening. Under the presidentship of Mr. Glazebrook, it has been found possible to carry out this suggestion. The first nocturn was, therefore, most appropriately attended on Friday last by Sir Oliver Lodge, and it was also fitting that he should choose as the theme of his discourse the possibility of being able to dispel that worst of all the powers of darkness—fog. Those of us who listened to his lectures some time ago on "Dust," received somewhat of a shock on Friday when reminded that it is 20 years since a comparatively little-known professor of Bedford College came prominently into public notice and esteem for the able and penetrative mind which he brought to bear on this commonplace thing. We have followed this professor with great interest from that period to the present point in his brilliant career, and, if we may so express it, we have always hoped that he would some day return to the "Dust" which he raised, and which raised him. It is, therefore, particularly gratifying to find that, notwithstanding his professional duties, his success, and the new and more industrial matters with which he has lately cast his lot, he is still able to continue his researches on a subject so particularly his own. We have referred to the proceedings on Friday last as a nocturn, because it is difficult to find a word which represents the kind of discourse that prevails at the Physical Society. Outside the House of Commons, it is doubtful whether there exists an institution which permits speeches to be so readily interrupted, and generally with such good effect, as does the Physical Society. Thus, at one point in Sir Oliver Lodge's description of his apparatus, Prof. Ayrton broke in; and although, at the time, the interruption was somewhat of a surprise, it turned out to be entirely justified, for it called attention to a matter of great interest, and gave it the right degree of prominence. The fact is, among experts, greater freedom of speech is possible than among a mixed audience; it takes a good man to know how to interrupt without being rude.

Sir Oliver Lodge began by referring to the work of Tyndall and Rayleigh, and the well known experiment performed upon dust by means of a heated rod. The dust is for convenience formed in a glass receiver by the burning of magnesium ribbon. Near the heated rod, within the receiver, is seen a dust-free layer, and streaming up from the rod, when a beam of light is caused to illuminate the dust, is seen a dark space, called the dust-free space. It was originally thought that the dust in these free spaces was burnt up by the hot body, and it was concluded that the dust must be organic. This theory is, however, wholly false, as the dust never gets into actual contact with the hot body, and the experiment works just as well with inorganic dust. Sir Oliver Lodge attributed it to a sort of radiometer effect, whereby the particles are kept away from the hot body. The action depends upon the temperature of the hot body, and upon the rate at which air is streaming away from it. It was also suggested that the air was repelled electrically, but this also proved to be a false notion; for, by electrifying the rod, it was found that, instead of the electrification modifying the dust-free coat, it expelled the whole of the dust from the container, and drove it to the walls. This experiment was shown by Sir Oliver Lodge in 1884 at Manchester, but similar results had been obtained by experimenters as far back as 1850. It was this which suggested the possibility of dispersing fogs by electrification. If cloud or mist is electrified, the particles cohere, the buoyancy is thus reduced, and they finally fall as rain. Experiments have been tried at a lead smelting factory to precipitate the fumes by a similar action, so as to be able to recover what is now in great measure lost. Now the success of any such method of fog or fume extinction depends upon the possibility of being able to generate a continuous discharge of electricity of one sign; which, of course, means separating the positive from the negative at the place of generation—a process of so-called "rectification." For this purpose Sir Oliver Lodge makes use of the Cooper-Hewitt mercury lamp, which was described and illustrated in the Electrical Review of January 16th of this year. Mr. Edward Robinson, who has assisted Sir Oliver Lodge in this investigation, is well known as a high-class manipulator, and the apparatus exhibited on Friday was a fine example of what can be achieved in this kind of work. The rectifiers were coupled up in sets of four, exactly like the four arms of a Wheatstone bridge. An alternator takes the place of the battery; and the discharge points take the place of the galvanometer. In order to increase the length of spark, each of the four arms can be made to contain more than one rectifier; thus it is found convenient to use three in each arm, connected "end on" to one another. Using one of the discharging points from this apparatus to electrify the dust in the receiver, there was an immediate visible coherence and consequent precipitation. Great interest was aroused as to the function of an auxiliary wire in the Cooper-Hewitt lamp; this wire is connected from the positive upper electrode (iron) to a conducting band which surrounds, and is in contact with the glass tube a few inches above the negative (mercury) electrode. We shall watch the development of this discussion, and hope for a further elucidation of the matter.

Street Obstruction by Electrical Undertakers.

The proceedings before the Board of Trade with regard to the obstructions caused by electric street boxes within the City of Westminster, have terminated in a recommendation by the Parliamentary Secretary to the Board of Trade that the parties should meet together and see if they cannot arrange terms. It appears that the Westminster City Council,

having experienced inconvenience from the frequent opening of boxes, have prescribed that there shall be access to the boxes in certain streets only from midnight to 9 a.m., and in certain other streets from 8 p.m. to 10 a.m. The companies not unnaturally objected to the restriction. It is provided by the schedule to the Electric Lighting (Clauses) Act, 1899, that the local authority may, with the approval of the Board of Trade, prescribe the hours during which the undertakers are to have access to street boxes, and if the undertakers, during any hours not so prescribed, remove or displace or keep removed or displaced the upper surface or covering of any box without the consent of the local authority, they shall be liable for each offence to a penalty not exceeding £5: provided that the undertakers shall not be subject to any such penalties as aforesaid if the Court are of opinion that the case was one of emergency, and that the undertakers complied with requirements of this section so far as reasonable in the circumstances.

It is important to notice that the duty of undertakers with regard to street boxes is not confined to the changing and testing of wires, and the connecting up of the premises of new consumers. By the regulations made by the Board of Trade under the Electric Lighting Act, 1888, it is provided that all street boxes shall be regularly inspected for the presence of gas, and if any influx or accumulation is discovered, the owner shall give immediate notice to the authority or company whose gas mains are laid in the neighbourhood of the street box. Compliance with this regulation involves a regular series of visits to a street box; and even assuming that the company had no other occasion to open a box from time to time, it would render periodical visits absolutely essential. We confess that we do not understand how any supply company could properly carry out the work of inspection within the hours prescribed by the Westminster City Council; and it is clear that the Board of Trade are of opinion that the regulations should be modified.

There are many who believe that a real solution of the difficulty could be found in the establishment of a system of subways in which mains could be laid without any interference with the surface of the road; but the prospects of these being established are not particularly bright.

Destructor and Electricity Stations in Small Towns.

A PAPER bearing the above title was read last night at the Leeds Local Section of the I.E.E., by Mr. S. D. Schofield, the electrical engineer to the Shipley U.D.C. The paper does not, as the title would indicate, deal generally with the subject of combined stations in small towns, but mainly with the results obtained at Shipley; and from these results the author draws certain general conclusions. These conclusions are not favourable to the combination, looked at from the point of view of the engineer in charge of the electricity works. Our own views, so frequently expressed in these columns, are pretty well known, viz., that whilst fully appreciating all that has been done to popularise the sanitary disposal of refuse by cremation, and whilst admitting the good results that have been accomplished in electricity works in the utilisation of the furnace heat, notably at St. Helens, Grays, Wrexham, Fulham, Accrington and Shipley, we have always protested against the claim that the combination was of any advantage to the electricity works. In short, we have never yet been able to see any considerable economy in using refuse instead of coal as fuel for the boilers. The whole of the advantages resulting from the combination are in favour of the sanitary authority only.

Mr. Schofield bears out not only this opinion, but also our recently expressed opinion, that municipal electrical engineers did not look with favour on refuse destructors as an adjunct to their stations. We must confess to a little surprise at the author's conclusions, as we had been looking forward to something in the way of a record from the Shipley station; something that would do more to justify the combined works than anything accomplished hitherto. With such a good load factor as is shown by the curves given in the paper, due to traction, lighting and motors, the destructor has had an exceptional opportunity of showing what it could do. And the result is an average of 40 B. of T. units per ton of refuse—results approximately equalled at Grays, Wrexham and St. Helens.

As to the calorific value of refuse, Mr. Schofield says this "varies almost directly as the price of coal in the same district." He clearly means "inversely," not "directly," as he proceeds: "If the coal is cheap, the refuse is good, and if coal is costly, the refuse is of less value." This, it has been shown by other writers, is not always the case. Thus at Shipley, the price of coal is 7s. a ton, and the practical value of the refuse is 40 units a ton, on the exceptionally good load factor of over 50 per cent.; at Grays, a small town on the outskirts of London, remote from coalfields, where the cost of coal is considerably more than at Shipley, the calorific value of the refuse is practically the same on a much lower load factor.

During the 12 months ending March, 1903, 6,525 tons of refuse were destroyed, at a cost in stokers' wages of 1s. 1½d. a ton—a somewhat high figure. Reckoning 49·8 units per ton (the results of one week's run on a good load, viz., a load factor of about 52 per cent.), the author calculates that this is just ½d. more than coal alone would have cost, reckoning the latter at 0·266d. per unit. But the latter figure is for fuel only, and does not appear to include stoking charges. From the figures given by the author, we calculate that the cost of stoking the coal was more than for refuse, viz., almost 1s. 6d. per ton. At 7·1 lbs. of coal per unit, the figure given in the paper, the relative costs are—for 49·8 units—refuse 1s. 1½d., and for coal nearly 1s. 3½d., a result slightly in favour of refuse, instead of ½d. against it as Mr. Schofield shows.

But the author of the paper makes certain deductions later from the value of the refuse, viz., 10 per cent. for cost of keeping stand-by boiler banked up with coal; 10 per cent. for unreliability of supply and varied character of refuse; and 5 per cent. for management and supervision.

After making these deductions from an average annual value of 40 units per ton of refuse, the resultant value to the electricity side of the works is 8·1d. per ton, as against a stoking cost of 1s. 1½d. Correcting this figure on the same lines as above by adding the stoking charges, we make the value of the refuse 10·1d., which still is lower than the cost of stoking. Looking at the above results, therefore, we are still of opinion that the catch phrase of the ½d. daily—"Gold from rubbish"—is both misleading and mischievous.

Stripping Brass from Iron by Electricity.

IN the process of making brazed iron joints in the manufacture of cycles, the tubes are frequently first dipped into a bath of molten brass covered with a flux. This causes a film of brass to adhere to the end of the tube and so facilitates brazing. In order to prepare the surface for enamelling, the brass has to be removed by filing and polishing, a method prejudicing the strength of the tube and necessitating an excessive amount of labour.

An electrolytic method of stripping the brass adhering to the steel, based upon the property of iron to assume a passive state under certain conditions and so become apparently electro-negative to brass, has been worked out by Mr. Charles F. Burgess in the Laboratory of Applied Electro-chemistry of Wisconsin. The tube is made the anode in a solution of normal sodium nitrate containing a little nitrite. If a pressure above 2·0 volts be applied, the iron soon assumes the passive state and the brass is corroded away, whilst but little of the current leaks away through the steel, provided that the applied electrical pressure is kept within reasonable limits and the solution is kept in good working order. The brass is thus efficiently dissolved and may be deposited upon a suitable cathode.

D

THE DESIGN OF IRECT-CURRENT MACHINERY.

By VAL. A. FYNN.

It would seem at first sight that so much has already been written and spoken on this subject of late, that a further contribution would have no chance of bringing forward any points of novelty, and the author, therefore, approaches his task with some diffidence. Most of the recent papers have, however, dealt with the design of large machines, and that in a more or less general way; the data which have been given, have applied to dynamos or motors constructed some time ago, and in many cases not likely to be repeated. It was further evident to the writer, from the discussion on the papers referred to, that there appeared to be a vague feeling of uncertainty as to the lines to be followed to obtain in every case, and without any possibility of doubt, the best possible results.

The author proposes in this paper to confine himself more particularly to the smaller machines, and to discuss the various points as they arise in following out the practical details of the design of a series of machines which have stood the test of daily practical work, and which are still being manufactured for the English market. He heartily agrees with Mr. C. C. Hawkins, when he says, "What we really want is not so much average figures, but the maxima that can be attained to serve as ideals." It is with the hope of finally discovering these "maxima" that the writer proposes to publish the figures relating to a series of contemporary machines, trusting that this example may induce others to do likewise, and show that they have succeeded in sailing closer to the wind.

In itself, the consideration of the design of small machines presents a series of most interesting points which do not arise when dealing with large units, and if only on that score it should not be neglected. Then again the number of small machines on the market is by far the greater, and what the writer has seen of these certainly does not point to finality having been reached as to either cost or performance. The question of commutation is quite as important for small as for large dynamos or motors, and it is proposed in the following to devote much attention to this vital point, but to deal with it only as far as is necessary for practical purposes, so as to keep the length of this article within bounds.

Many of the following statements will, no doubt, lack novelty to the majority; if we include them, it is only for the sake of completeness. Beginning with the smallest sizes, we are naturally led to speak principally of motors, and starting to discuss the frame, we are at once met with a difficulty. The motors now on the market are made protected or enclosed to a varying degree, but the same types are described by different names according only to the whim of the maker.

This state of things is prejudicial to the trade in general, and it induced a firm some time ago to send out circulars suggesting the adoption of uniform designations. The effort remained fruitless, only, we hope, because sufficient publicity was not given to the proposal, and we therefore venture to broach the subject again and propose the designations hereunder. The names chosen for the different types may not be the best; the writer will be the first to welcome any improvements, and will feel satisfied if he succeed in arousing some interest in the question.

"Protected type" (fig. 1). The casing of the motor forms part of the magnetic circuit, and covers in the poles, the field coils, and the whole of the running portions except the pulley; the end covers, giving free access to the air, allow good ventilation, which may be increased by the use of fans.

"Enclosed type" (fig. 2). The casing of this type is exactly similar to Type 1, but the openings in the end covers are covered with stout copper wire gauze; this allows a certain amount of ventilation, which may be increased by the use of fans.

"Gas-tight type" (fig. 3). Here again the casing is the same as for Type 1, but the end covers being solid, the machine is actually gas-tight.

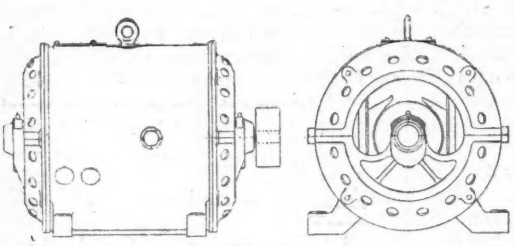


Fig. 1.

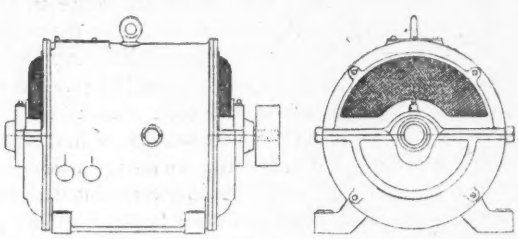


Fig. 2.

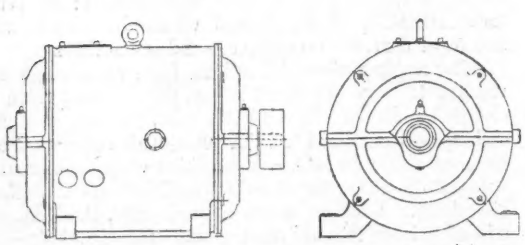


Fig. 3.

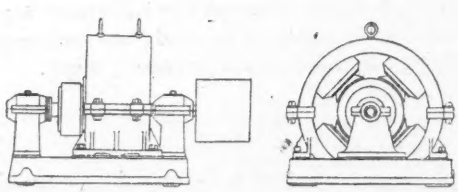


Fig. 4.

"Open type" (fig. 4), or ordinary dynamo type.

What type is to be used for a given job must be determined by the circumstances of the case. It is by no means indifferent, either from the point of view of the purchaser or from that of the manufacturer, which type is chosen or supplied when guarantees as to temperature rise are asked for and given.

It is clear that the protected type (using the designations suggested above) will give the greatest output for a given rise of temperature, or, to put it in another way, will show the smallest temperature rise for a given output.

An average of a number of tests on motors, designed on the lines of figs. 1, 2 and 3, showed that, for equal loads, the final temperature rise of the enclosed type exceeded that of the protected type by about 30° F., and that the addition of a fan to the enclosed type reduced the difference to some 17° F. for normal speeds. The gauze used consisted of a mesh 12 to the inch of S.W.G. No. 24.

The use of a fan might suggest a serious additional loss, but tests have shown that when the latter was properly constructed the necessary draught could be obtained at the expense of from 50 to 80 watts for motors up to, say, 30 B.H.P. It was also found that a protected-type motor would give 1·5 times as big an output as a gas-tight one for the same temperature rise.

These figures are bound to vary somewhat with the genera

design of the motor, and it would be interesting to know what results have been obtained with other designs.

The author believes that these figures can be improved upon, if, instead of using the same windings in the various types, as was the case in the tests referred to, special designs were got out redistributing the losses to suit each type. In settling the general outline of the carcase the requirements of all these types should be kept in mind.

The round frame has met with universal approval, and deservedly so, since it offers the greatest possible advantages in the pattern making, casting and tooling.

Dealing with the frames of smaller motors first, in order to get the best possible results for type 1, we must protect the motor only as far as is required by the fire insurance companies, allowing the air as free an access as possible to all parts and avoiding all "pockets." The lugs of the commutator form a natural fan which produces a very marked current of air through such motors, and when auxiliary fans are used, care should be taken that both produce a current of air in the *same* direction.

The general lines suitable for type 1 happily are the best for the second type; the first being transformed into the second by covering all openings with gauze or perforated sheet metal. The gauze surface should be as large as possible, for obvious reasons, and the advantage is most marked when a fan is used, as, owing to the greater area, a lower velocity will suffice to change the air with sufficient frequency: the meshes of the gauze are thus less liable to get clogged and less of the coarser dust will get into the machine.

The gas-tight type will be best suited by as large a radiating surface as possible. A fan might possibly be of use even in connection with this type, since the heat generated in the armature has a long way to travel through the high insulating air, and the armature probably reaches a very high temperature indeed, before inducing a sufficient draught. It is, of course, easier to get rid of heat by conduction than by radiation.

A very vital point in the design of the frame generally is to secure accessibility to the brushes and commutator, and any attempt to crowd that all-important gear into an unduly restricted space is to be strongly deprecated. The gain in material and weight is not worth considering as against the far greater convenience to the user, leading to better attention, and thus reducing the possibilities of breakdown.

Turning to the larger machines built on the lines of the modern multipolar (type 4), we find there again that the round yoke is best, and is also used by most makers. There is little to say about this part of the machine beyond drawing attention to the necessity for absolute rigidity.

The motor frame or the yoke may be made of steel or cast-iron, there are *pros* and *cons* in either case. On the whole, the writer still favours the adoption of cast-iron for this purpose. The margin in favour of this material grows smaller and smaller, however, as the tooling qualities improve, the prices grow less, and deliveries for steel castings become shorter.

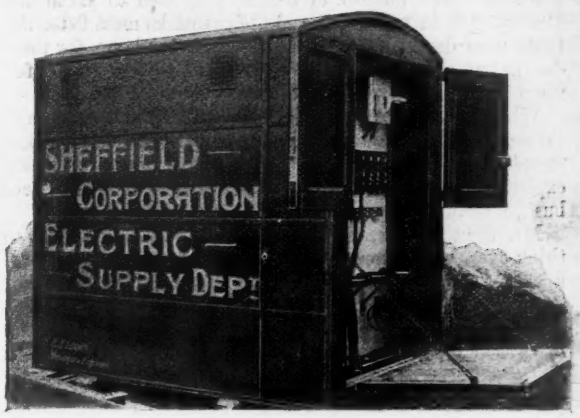
There is no doubt that steel is the best material for poles and pole shoes. In many cases it will be permissible to make both body and shoe solid, but the best results will no doubt be obtained with laminated poles, the machines turning out both cooler and more efficient, particularly when closely designed and using the smallest possible air-gaps mechanically, as is the case with the series under consideration. The adoption of laminated poles makes the machine more readily adaptable to special cases, making it unnecessary for the designer to watch the proportions of his slots closely with a view to reducing the heating of the poles.

(To be continued.)

AN EMERGENCY SUB-STATION.

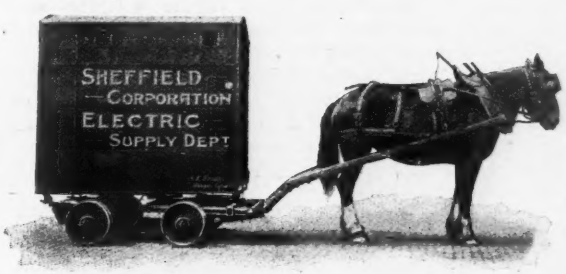
It frequently happens that a would-be consumer situated beyond the reach of the supply mains, or one desiring more power than the existing network is able to convey, is discouraged when he learns the length of time which must elapse before adequate provision can be made to supply him.

With a view to minimising such delays as far as possible, and for general emergency work, Mr. S. E. Fedden, the manager of the Sheffield Corporation Electric Supply Department, has designed and put into service a transportable sub-station, which takes the form of a substantial pantechnicon, fitted with massive wheels and brakes, and containing two 50-kw. transformers, high-pressure fuses for two feeders, and



Back View, showing Switchgear.

low-pressure switchgear to accommodate several four-core distributors, with suitable provision for expeditiously tailing and sealing the ends of the cables, which are brought up from the pipes or trench underneath the van. This equip-



Emergency Sub-station on the Road.

ment provides for a supply of single or two-phase current at 400 or 200 volts.

The whole apparatus can be drawn about by horses, deposited in a convenient spot, and connected-up in a few hours to supply any temporary demand, such as an exhibition, construction works, or permanent consumers during the erection of a district sub-station, to which the load can be changed-over on completion, and the van moved on to some other sphere of usefulness.

GAS-PIPE v. COPPER: A REPLY.

By E. KILBURN SCOTT, M.I.E.E., A.M.I.C.E.

That anyone in these enlightened days should be able to write as Mr. C. A. Smith has done in his article, "Gas Pipe *v.* Copper," shows courage, if nothing else. We all know from the start what rank heresy it is, and that there must be several niggers somewhere; but who, in these hurry-scurry days, is going to turn aside from the sweeping tide of electrical progress to point out where the niggers lie? It is a thankless job in any case, for Mr. Smith might remain unconvinced out of sheer cussedness, like our friends the gas-lighting people.

On the other hand, I am not at all sure that Mr. Smith is not trying to perpetrate a joke, and intends his article as a sort of red rag. Whether this is so or no, it is a dangerous sort of information, which must be scotched, for electrical

engineers cannot afford to leave any straws about for the followers of old heresies to clutch at, and so to further retard progress.

The first thing which occurred to me when I read the article was the woeful *fiasco* of the Birmingham Compressed Air Co. I remember it well, for, as an improver in J. Fowlers & Co.'s works, some 16 years ago, I helped to make those compressed air engines which were to work such wonders. The number of people who used to come and gloat over them was great, and their remarks most flattering (they were decent-looking engines, and very large for those days), but somehow we who were working on the job felt there were niggers somewhere, and so it turned out.

Whether it was bad finance, the difficulty and expense of laying pipes, or the low efficiency of the system when completed, I will not discuss. There are, no doubt, plausible explanations, but the main fact is, that the company went bust, or shall we say "Popp?"

Mr. Smith gives us the Paris compressed-air system to think over, but it won't do. Paris has the most wonderful knack of showing results in the most unlikely quarters. For example, where else in the whole world could so many different traction systems exist side by side, and all of them *apparently* doing well? I can't explain it, but there it is. Volatile Paris is certainly no place for a businesslike, industrial, or a clod-hopping district in this country to take lessons from.

If Mr. Smith transmits producer (Mond) gas over long distances, some of it is bound to leak, and then what about the carbon monoxide? Does he not remember water-gas, and the inquest at the Leeds Forge on the foremen who were poisoned, and how it was nearly a case of up-dicky with some of the jury too? There were many reasons for the water-gas companies going bust, finance being amongst them, but the thing which finally did for water-gas was the cases of poisoning. The late Mr. Sampson Fox tried to mend matters by making the gas smell nice, so that people should know when it was about, but it was all no go. Again, I have reason to know of those days, for several personal friends (some employed at the Forge), and, I regret to say, some relatives, backed water-gas with their money. A thing like that sticks, and it requires a heap of chemical and physical facts to shift it.

At Brussels, gas engine sub-stations were used to help the electric lighting, and the job was well engineered. They are now out of use, and the latest development is the equipment of a large electric power station some distance outside the city. Mr. Smith may say the above-mentioned failures were solely due to bad finance and bad management. Very well, assume it so. Where is there a more disastrous record of early finance than that which characterised the first few years of electrical history in this country? We as a profession are even now suffering from the mad speculation which caused the 1882 Act to be brought in. Yet electrical engineering has lived through it all, and through the grossest of mismanagement. Why? Because the science of it is founded on bedrock. We do not make approximations of power by means of indicator diagrams or take records of volume in quart pots, but all electrical measurements are absolute, and right down on the nail. It is the nature of electricity to come out on top every time.

From the way in which Mr. Smith's figures are presented, I cannot think that he is accustomed to the preparation of estimates. For example, he allows 2s. 9d. per cb. yd. for excavation, and we are left to assume that the piping gets into the excavation on its own, whilst the excavation presumably remains open for ever more. At any rate, Mr. Smith doesn't allow us any money to complete the funeral. He may retort that he has included all these little extras; but if so, why in the world doesn't he say so? When he presents his own figures correctly, it will be soon enough to compare costs.

One feature of the article is that the names of certain engineers are brought in to confirm his statements. Thus, Mr. Earle is said to have pointed out that "beyond a certain point centralisation does not pay." I don't know what the context of this remark is, but feel sure Mr. Earle is too progressive an engineer to suggest that power schemes such as those of South Yorkshire, Clyde Valley and South Wales, cover *too large* an area in each case, and so far as I know, no electrical engineer has yet proposed to have one central power station for the British Isles.

Mr. Smith harps on the expensiveness of electric sub-stations, having in his mind rotary converters, motor-generators, &c. He also says that alternators generate electricity in a form which is not wanted for ordinary purposes. In other words, he cuts out of the discussion the unique simplicity of the static transformer sub-station and distribution of three-phase current to customers, as at Erith and Dublin, and hundreds of places abroad. Glasgow and Manchester are mentioned, but it is a moral certainty that, if they were starting to-day, and with our present knowledge, direct current would not have a look in.

The writer of the article is good enough to say that, if overhead transmission were permissible in England, his comparisons would be much more in favour of electrical transmission. But who says that overhead transmission is not permissible? If Mr. Smith will go to the Board of Trade, he will find that printed regulations are one thing, and the opinion of the officials another. As a matter of fact, three-phase overhead transmission lines were erected in this country several years ago, and the Board of Trade has not pulled them down, or, in fact, shown the least disposition to interfere.

At this moment several power companies (Gloucester, Kent, North Wales, &c.), are about to use high-tension overhead transmission lines, and the Board of Trade will see to it that powers to erect such lines are not *unreasonably* withheld by any local bodies or individuals.

Mr. Smith makes a point when he mentions cable manufacturers. There is no doubt that power companies must not allow cable makers to become interested financially, for the cable makers naturally want every wire to go underground.

I consider the reference to the South Staffordshire Mond Gas Co. rather unfortunate, for they are not yet out of the wood, and considering the "crownings in" which are of frequent occurrence in their area, especially now the mines are being unwatered, the wood is pretty dense. I venture to prophecy that this company will, if it lives long enough, come to transmitting energy through simple copper wires.

Electrical engineers have no quarrel with Mr. Smith about using gas engines for generating, or—as will probably come in due time—gas turbines. What they do say is, that the transmission of energy, and to a very large extent its utilisation, must be electrical. Why, indeed, should we carry a material substance through pipes, when we can do all that is necessary by simply vibrating the ether. The electric motor has also obtained too firm a hold to be displaced by the gas-driven motor driving line shafting in the bad old way.

ELECTRICALLY WELDED JOINTS.

Once more Glasgow leads the way! This time she begins an experiment in electric welding, primarily for her own benefit, but indirectly for the good of Britain.

The Corporation has arranged with the Lorain Steel Co., Johnstown, U.S.A., to carry out the electric welding of their new lines to Paisley and Cambuslang, and also a few short extensions within the City. The distance from Crookston to Paisley is about 2 miles, and the Cambuslang extension is about the same length. Both of these extensions will be opened for traffic in about 10 days. The Lorain Co. have also arranged to weld the rails on a portion of the old track. This work is being carried out when the cars are off, between 1 and 5 a.m.

The total number of joints to be welded under this contract is about 2,000, the Corporation reserving the power to have up to another 1,000 joints welded.

This is the first trial in Europe of electrically welding rail joints, and it will be of much interest to tramway managers and engineers.

On Friday, 13th inst., the members of the Tramways Committee of the Corporation of Glasgow visited the scene of operations, and were much struck with the completeness of the plant, and with the ease and rapidity with which the whole process was carried through.

The system is not new, and will be familiar to most of the readers of American journals. Already over 100 miles of track in the States have the rails welded by this process, but it cannot be said that this is very good showing for a system which made its first practical appearance in 1897, when it is remembered that the track mileage in the States is much over 20,000. The reason must be that the operation of welding is an expensive one compared to the mechanical joint and bond, because of the large and costly equipment required, and not that the results are not successful, for the broken joints have never exceeded 1 per cent., and this has been reduced since 1901 to one-tenth the amount. If all accounts are

tric, these results are greatly better than the results obtained hitherto with the cupola cast weld.

The Lorain weld is performed by an alternating current of 25,000 to 30,000 amperes at 5 to 7 volts, transmitted to the welding bars and rail ends by heavy hinged jaws under pressure from a hand-operated hydraulic pump. The low-pressure current is obtained from a transformer which is suspended between the welding jaws immediately over the joint. The primary of the transformer is fed from a rotary converter, which in turn takes current—about 250 amperes—at 500 volts from the trolley wires (not without very

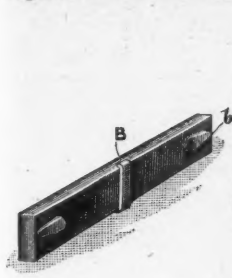


FIG. 1.

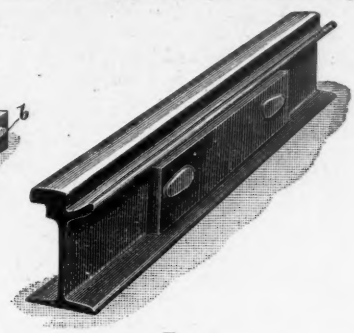


FIG. 2.

heavy loss per mile, we imagine). The jaws and welding contacts are cooled by water circulated by a motor pump; the motor serving also to move the crane from which the welder is hung.

An advance car carries a sand-blast equipment, driven by a 10-H.P. motor, by which the webs, at the rail ends to be welded, are scoured.

A rolled steel bar shown in fig. 1 is clamped to each side of the web, with the 1 in. × ½ in. steel strip, B, covering the joint. Within two minutes of the application of current the centre weld is made, and the welding jaws are moved at once to one of the contact bosses, *b*, where current and welding pressure are applied again. Here, however, the hydraulic pressure, of 35 tons per sq. in., is maintained until the metal has ceased to glow, when it is released and the other end taken in grip. The object of this wait is to make the weld tough. This is rendered essential, because the bars when welded at the ends are elongated by the heat developed at the central weld, and, when cooling, tend to pull the rail ends together, themselves being left in a state of tensile stress, which, of course, increases with a decreased winter temperature.

New rails should not require the services of the emery grinding outfit which follows the two welding cars in a car of its own when old rails are being set up for life.

It is well seen from this description that a small line can never hope to enjoy an electrically-welded track. The cost per joint would be far too heavy. But a large undertaking (or a group of small systems, adjacently placed) may well consider the outlay—after giving very careful thought to the mechanical and commercial advantages set out by the exploiters of the thermit weld, or the best of the rigid built-up joints.

One disadvantage of the electric weld that suggests itself, is the difficulty of its application in a town new to electric traction, where the power station is not completed much before the completion of the tracks. Doubtless this can be got over, if only by adding another car or two to the train, containing a complete generating station having a capacity of 150 KW.

THE NEW WORKS OF MESSRS. BENHAM AND FROUD, LTD.

On Monday last we spent a most interesting hour in the new works which have been erected by Messrs. Benham & Froud, Ltd., at Willesden. When the firm found it necessary to remove from Chandos Street, where the works and offices had been so long located together, it was decided to take extensive offices and showrooms in a fine new building which has been called Chandos House, and is situated in Store Street, W.C., just off Tottenham Court Road; but for the manufacturing premises it was resolved to go farther afield, and ultimately land was purchased off the Victoria Road, Willesden, just about 10 minutes' walk from Willesden Junction station. Upon this site a fine set of workshops, laid out on modern principles and with electric lighting and power equipment, has been erected.

The business of the firm needs no explaining, for it has a proud record of getting on for a century and a quarter, and its reputation for high-class art metal working, is thoroughly well-established. As one instance of the sort of thing done by the firm in the "good old times," may be mentioned the ball and cross which have stood out o'er London at an over-towering height on the top of St. Paul's Cathedral since the year 1821. Could they but speak! But the age of the firm and its long history are not by any means accompanied by the least suspicion of senile decay, as a visit to the Store Street showrooms, or a run through the Willesden shops, will show.

We cannot forego a passing reference to one very touching tribute to the good relationship between master and man which has so long been maintained; in the course of our progress through the works, following the process of manufacture from stage to stage, we came upon a score of busy workers making music with the clanging of many hammers, and our congenial pilot (Mr. Laws, the works manager), in an aside, singling out three hardy-looking old men engaged assiduously at their task, remarked that these three together had a combined record of 130 years' service with the firm. We were also impressed, as we passed from bench to bench, with the absorbing interest which each man seemed to take in his work, and the kindly courtesy which so many displayed in exhibiting their own particular part in the process of manufacture.

The offices front on to a newly-made thoroughfare off the Victoria Road, and they are separated from the works by a small yard. The workshops themselves are laid out in two rows, with a paved way, which is lighted at night electrically, running between them. All of the shops have windows opening on to this way, so that all departments are to some extent under observation. The general store is a roomy building where the "raw" material, such as copper and iron bars, sheeting, and so on, are received from the metal manufacturer of special dimensions for working up for making ornamental gateways, copper domestic utensils, ecclesiastical artistic work, lecterns, electric light fittings and so on, are brought in, and are cut to specially-required shapes as a preliminary before passing to the shops for being worked up. The metal working department is naturally next, and the various machines doing service therein are driven from a main shaft which is run by belt from a large Tangye gas engine contained in the power house. The brass finishing shop has a number of lathes, a cock-boring machine and other tools driven by belting, &c., from a shaft which is revolved by an electric motor. The wood-working shop also has its motor housed in, so as to be well protected from sawdust; this shop contains a number of sawing, drilling, wood-carving and other tools. A third motor does service for working the various tools, polishing spindles, scratch brushes, &c., in the brass-polishing and finishing rooms.

The power equipment consists of a Dowson type gas producer, burning anthracite, and supplying gas to the Tangye gas engine already referred to, as well as to a Crossley gas engine. These engines drive two Crompton dynamos, the two machines being arranged to run in parallel either for a 220-volt lighting or power supply. The Tangye-Crompton set is mainly drawn on for the motor supply, the Crossley-Crompton plant being intended more particularly for lighting purposes. The switchboard is the work of Messrs. Crompton & Co., Ltd.

The electrical installation was carried out to the plans of the firm's own electrical engineer.

The workshops are spacious and well lit on the most approved method, and we were specially struck with the size of the smiths' shop, which provides space for architectural wrought-iron work of almost any dimensions. At the present time, the large staff of smiths is engaged upon a large chancel screen for a church in the West of England, and a large pair for a brewery, besides a number of electroliers, of which the firm makes a speciality.

At present the employés at work number about 250; the number was somewhat below this at the time of our visit on Monday, for even in the best-managed works the old Saint Monday difficulty is experienced. There is accommodation in the workshops for another 100 men, and further, there is plenty of land available for extensions of premises when these become necessary.

Work does not commence until 8 a.m., so that there is no break for meals immediately after the shops have been opened, with the consequent loss of time and efficiency. As the Chandos Works are situated in a somewhat secluded part of Willesden, as yet devoid of shops, the convenience of the men has been very considerately studied by the establishment of a dining room, where a plentiful bill of fare at low prices must be a real boon, and even if, as is expected, the profit on the turnover does not pay the expenses of this interesting department, the margin of loss will be only so much set aside for increasing the comfort of the employés and aiding in the maintenance of good relations.

In the electric light fittings department of the Store Street showrooms we have seen some very tasteful things in the way of electroliers, brackets, and so on, that have passed through these factories, and we have no doubt that consulting engineers, architects, and the trade will find it worth while taking their clients here for a look round at some time or other.

PHYSICAL SOCIETY.

Dr. R. T. Glazebrook, F.R.S., presided at the meeting held on October 23rd, when a paper on "The Bending of Magnetometer Deflection Bars" was read by Dr. Chree. A theoretical paper contributed to the Society by the present author in May, 1901, proved, amongst other results, that the bending of the deflection bar of an ordinary magnetometer, under the combined weight of the bar and its load, must increase the distance between the deflecting and deflected magnets, during a determination of horizontal force, to an extent which is not negligible. This conclusion has been borne out by direct observations made at the National Physical Laboratory on a number of magnetometer bars, including specimens from the leading makers. The mean results thus obtained are recorded in the present paper. The great majority of the data were derived from direct observations made with a pair of microscopes. But a method is described whereby the necessary information can be deduced without the aid of microscopes, from the magnetometer's own readings. The magnetometer is set up exactly as in an ordinary deflection experiment, with the deflecting magnet on its carriage at any convenient position on the deflection bar, and equal weights are hung up symmetrically, one on each arm. The consequent increase in distance between the two magnets diminishes slightly the deflecting force on the deflected magnet, and a slight change of reading is observed in the magnetometer telescope. The weights are put off and on several times,

and the mean change of reading determined. As a check, it is well to observe at two distances. From the change of reading, it is possible to determine the increase in distance between the two magnets. In many magnetometers, the increase in distance due to the bending is roughly proportional to the distance itself. In the case of bars by the Cambridge Instrument Co., the bending increased the distance by almost exactly one part in 10,000 at all distances. It is hoped that the method employed will prove useful to magnetic observers who have not ready access to a physical laboratory.

Prof. S. P. Thompson asked why instrument makers could not design a better instrument, referring especially to the deflection bar itself, which was not of a good form. Although the error referred to by the author of the paper seemed large, it could not be greater than errors arising from inaccuracy in the setting of the carriage or from other causes inherent in a deflection experiment.

Dr. W. Watson said that with regard to the accuracy of the setting of the carriage, it was not easy to set it to 0·1 mm., but inaccuracies of setting to a certain extent compensated each other.

The Chairman remarked that a large number of errors entered into the determination of horizontal force, and they were being investigated one by one at the National Physical Laboratory.

Dr. Chree, in reply, said that various attempts had been made to get rid of the bending effect, but if it could be measured accurately, its magnitude was of minor importance.

A paper "On the Magnetism of Basalt and the Magnetic Behaviour of Basaltic Bars when Heated in Air" was read by Dr. G. E. Allan.

Bars cut from basalt obtained from Rowley Regis and from Linz, Germany, were tested by means of a magnetometric method to determine their magnetic properties at temperatures from 15° to 800° C. Hysteresis curves are given, and the temperature permeability curves show that whilst the English basalt has, in general, a maximum permeability near 500° C. followed by a minimum about 550° C., the temperature of maximum permeability in the case of the German basalt lay in the neighbourhood of 50° C., there being a subsequent gradual loss of strength with rise of temperature. Sections of heated and unheated rocks are given, showing evidence of chemical change in some of the rock constituents, and a table of values of susceptibility of the specimens is appended.

Prof. W. F. Barrett, in a letter sent to the secretaries, said that Dr. Allan's paper was one of great interest and considerable importance. Several years ago he examined the magnetic properties of various specimens of columnar basalt which had been taken from the Giant's Causeway in Co. Antrim, and a note on the results of this investigation was published in the *Proceedings of the Royal Dublin Society* for December, 1889. Each block was found permanently magnetised with a strongly-marked north and south pole, the magnetic axis running diagonally through the block and inclined to the horizon approximately at the angle of dip. As the blocks formed part of vertical columns in the Causeway, their magnetisation was undoubtedly due to the earth's magnetic field, the concave end of each block—for the ends are not plane, but slightly concave or convex—was (in all the blocks examined) found to be a north-seeking pole, and must, therefore, have been downwards when *in situ* at the Causeway. The long retentivity of the direction of the original magnetisation in spite of rough usage was somewhat remarkable.

Dr. Watson then showed some experiments with electrical oscillations.

CORRESPONDENCE.

Letters received after first post on Wednesday morning cannot appear until the following week.

Main Line Electric Traction.

In your interesting and valuable leading article in to-day's Review, you state that the results attained with the new Eichberg-Winter single-phase motor "practically solve the traction problem."

Those who know this motor best are fully prepared to endorse your optimistic opinion in regard to the same; but there are some problems in long-distance railway work not solved by the invention of a good motor only.

A single-phase motor of the type indicated will enable high line voltages to be utilised and consequently reduce the cost of copper conductors, while at the same time eliminating the use of rotary converter sub-stations. This is a great gain, but it is not all.

Such a system would still require the use of expensive third-rail or overhead wire construction at all points of the line, including sidings, tunnels, station yards, bridges, &c., and at such points the work is costly.

In such a system there would be no appreciable saving in the amount of generating plant used, nor would wide fluctuations in load be eliminated. Trains would still take from the line about three times the normal amount of current when starting from stations, and a large increase of current above the normal on upward gradients. Even if stationary storage batteries are used "floating" on the line, as in existing practice, a constant load factor cannot be had; but batteries cannot well be used under existing methods on a purely alternating-current line.

In the conditions stated in your article as essential to success, the most important and necessary one, that of absolute safety and certainty of operation under all conditions, and irrespective of accidents to high-voltage transmission systems, is entirely omitted. No system depending solely upon such a transmission system can ever succeed.

In the article describing what is known as the "multiple supply system" in your issue of the 6th inst., the above difficulties are described and a solution offered.

If we are, by means of this new and excellent motor, enabled to secure all the advantages of high voltage transmission, and if we combine this motor with the methods of the multiple system, what shall we attain?

1. High-voltage line supply, less the cost and risk involved in the use of conductors over 40 per cent. of the total line mileage, the parts omitted being those which are the most difficult and expensive to construct and maintain.

2. In the multiple supply system a new method of using and charging batteries has been designed, whereby a small plant working continuously at a mean load factor of 100 per cent. for many hours, will do as much work as a plant twice the size working under a fluctuating load during the hours when most trains are in operation. The small plant will do more work in each 24 hours than the large one, and cost only one-half as much.

3. The cost of power would be less with the multiple supply system, because where an absolutely constant load can be had, irrespective of line load, power gas engines can be used to drive alternators in parallel without difficulty, while the transformer and other losses in a purely direct transmission system are greater than in a mixed system, because the new model Edison battery has a very high charging efficiency. The methods by which the 100 per cent. load factor may be had cannot yet be disclosed, for patent reasons, but they are remarkably simple and efficient.

4. The vital condition, the ability to carry a train over a "dead" line section, or to its destination, can only be secured by the multiple supply system.

It would seem, therefore, that if the advantages of the new motor are combined with the simple line construction, the ideal power house conditions and the self-contained train, we shall indeed have a model system at a cost which will ensure its general adoption.

Multiple Supply.

November 13*th*, 1903.

Waste of Energy in Tendering.

The suggestions of Messrs. Dykes and Rawlings in your last issue appear to me to be very good for saving energy in tendering, especially for the small contractor. The latter would have plenty of time to think of running—say, a baked potato can, or anything, in fact, except electrical contracting. If any scheme were carried out to limit the number of contractors for a contract to six, it would only be natural that the six selected would be the biggest or best known six. The small man would have no chance of showing his ability to do the work, perhaps better and cheaper than those living on the reputation of good work done in the past.

The arrangement would also be very convenient for a consulting engineer wishing to favour or boycott any particular firm.

R. A.

London, *November* 16*th*, 1903.

The letter from Mr. Dykes in your last issue lays bare the truth from the consulting engineer's point of view.

Nor is this truth to be lightly regarded, coming as it does from one of our leading and most experienced engineers. Mr. Dykes is not alone in his opinions, for I know them to exactly coincide with those of other leading men in the profession who have openly expressed their desire to give counsel and support in any direction calculated to check the existing evil.

It is sincerely to be desired that the advice given by Mr. Dykes will have the timely effect of bringing all *bonâ fide*

contractors closer together, and closing their ranks against any suspicion of disloyalty or such conduct as has been described, ere the present wave of enthusiasm has passed. When this is realised in a practical manner there should be no difficulty in coming to an understanding with the consulting engineers, and thereby, if not actually wiping out, at least greatly modifying the existing conditions.

Duncan Watson.

London, *November 17th*, 1903.

The Justified Wail of a Junior.

Apropos of your remarks upon chief engineers changing from place to place so frequently, the same applies to the junior staff; and if there are many cases like the following, there is reason enough.

A vacancy occurring on the staff of a large supply station, was advertised, and an outsider—*experience nil*—duly appointed, completely ignoring the capabilities of the juniors, who will have to teach the new man his work, and who have carried it on during the interval while the post was vacant.

Is not this encouraging to the juniors who have been waiting for such an opportunity to improve their position? It is enough to make one give up the electrical profession and rather be a railway porter; there is every chance of promotion, on quite as good a salary.

Now, who is to blame for such cases—the chief? No; he, as a rule, works with his hands tied up by a council ideas of business are about bordering on insanity, he cannot help it; but if he does not know what class of man he requires for an assistant, who does? A jeweller would never engage a blacksmith to repair watches.

It is time our worthy chiefs formed some association to enable them to have a little more freedom in such matters. I put this as a suggestion, as in the face of some recent events there seems to be a necessity for some such course.

Junior.

London, *November 4th*, 1903.

The Electric Heating of Railway Carriages.

I have just read several articles in certain electrical journals on "The Electric Heating of Railway Carriages." This has suggested to me the idea of putting before your readers a system that I conceived some years ago, the principle of which was the heating of carriages simply and economically by means of an electric current generated by a dynamo actuated by the motion of the train itself. My idea was as follows. (For further particulars see the *Dictionnaire d'Electricité*, by G. Dumont, published by Larousse) :—A dynamo driven from one of the axles of a carriage sends a current through a circuit extending throughout the length of the train. From this circuit the wires which go to the heaters are taken, going through them in the form of spirals in the direction of their length. The heaters are previously filled with a substance which has a high latent heat of fusion, such as sodium acetate (crystallised), sodium hyposulphite, &c. On starting, the heaters are plunged into boiling water, and after a little while are placed in the train and connected up in circuit. While the train is stationary no particular effect is produced, but as soon as it starts and attains sufficient speed, the current produced by the dynamo passes through the heaters. Now as the wires in the heaters have less cross-sectional area than those in the main circuit, they become heated in proportion to their resistance, and the heat thus generated compensates for the heat which is carried off by the melted body or the material used (various solid substances, such as asbestos, sand, &c., might also be used)—that is to say, the heat lost by radiation, which is used to heat the vehicle. As the heaters will remain active during six hours at least, any stoppage of less duration will not let them get so cold as to need replacing. It follows, then, that a train would be able to run from Calais to Brindisi, from the frontier of Spain to that of Russia, to run for any length of time on a circle line, or backwards and forwards between two points, without it being necessary to change the heaters. The resulting advantages to the companies and their passengers are easily seen, the reduction of the number of warmers in use, the installations doing away with the number of changes, which are always disagreeable, especially at night.

A special arrangement puts out of circuit every heater, as too much warmth would be dangerous, and puts it in again when the temperature becomes normal. It might be added that the system lends itself to the interchange of carriages between lines on which it is adopted, since it will operate after comparatively long periods of rest—that is to say, after interruptions in the compensation for lost heat.

Donati Tommasi, D.Sc.

Paris.

Jointless Section Induction Coils.

In reply to Mr. Apps's letter in last week's issue, I do not think it necessary, in a journal read chiefly by electricians, to reply to most of his criticisms on my new coil winding, especially as I have just read a paper on the subject before the Röntgen Society, which will be published in due course. With your permission I will, however, state that each paper section will stand a spark about $\frac{3}{8}$ in. long, from a step-up transformer, and needs to hold out in the case of a 12-in. coil, against less than $\frac{1}{24}$ in., *i.e.*, that due to about 180 turns of wire. Any further insulation, such as that, for instance, shown in the Klingelfuss nearly closed iron circuit coil, is quite unnecessary, and the safety margin is much larger than in Mr. Apps's own coils. As regards the effect of expansion in the coils due to a hot climate, if we compressed them when cold there might be some ground for his forebodings, but they are compressed *when quite hot*, and take up permanently the position they had when already hot and expanded. Time will settle this matter. Meantime my guarantee may suffice.

Now, as to Mr. Apps's theories on coils in general, wireless telegraphy, &c. These seem to date, like his experiments and the authority he quotes, Ruhmkorff, from so far back that I cannot take them seriously, and much prefer to read the careful contributions of—say, Klingelfuss, to the technical press. Considering that some people still look on Mr. Apps as an authority, is it surprising that in a book on coils recently published in Berlin there is scarcely any mention of those made in England, and none of any improvements? To my knowledge two Continental firms have made improvements something like mine, *and carefully kept them a secret*, till my patent appeared. Why should they do this if the changes are useless? As regards the suitability of low resistance secondaries for condenser work, of course the resistance should be made to suit the capacity. The trouble is to make the resistance low, not high. On this point I have much pleasure in referring Mr. Apps to the Cantor Lecture of Prof. Fleming, delivered March 9th this year, in which the absolute necessity of a low resistance is clearly proved.

In another lecture it was recommended that a coil, for wireless purposes, should be rated according to the spark it will give with a condenser of $\frac{1}{10}$ microfarad in parallel, and $\frac{1}{100}$ of a microfarad. I shall be more than content to have mine so rated. As regards the great benefits of compression, I can refer him to the writings of Tesla three or four years ago, but cannot give a date. Compression acts in the same way that oil does. He appears to regard unnecessary joints in the wire, ohmic resistance and plenty of air space for internal molecular bombardment as unobjectionable, and even desirable, features, in the secondary winding. According to him, induction coils having these peculiarities reached perfection, in his hands, about the year 1868, after he had tried and discarded everything thought of by other people in the interval since that date.

Leslie Miller.

London, *November 17th*, 1903.

The Central Station Battery.

If Mr. Abraham had read the whole of my letter as carefully as he read the first two paragraphs, he would have noticed that I stated that the readings were usually taken on overcharge day, *and not at the end* of overcharge,

Although this may not be the case in the station with which Mr. Abraham is connected, I can speak from experience that it is the custom in a large number of central stations with which I have had to do.

We are not all so fond of displaying our wisdom or ignorance, as the case may be, and consequently are grateful for the editor allowing one to hide his shining light. It is a pity, however, that Mr. Abraham "bid his light under a bushel" when he wrote about *the Walsall cell recorder*. Let us hope that it was modesty only, as it seems hardly correct for a person to write, apparently, as an entirely disinterested person and puff up an article which is his own invention.

I must admit that although I have devoted several years *entirely* to battery work, experimental and otherwise, and have probably had more batteries through my hands than Mr. Abraham has had cells, there are still many points on which I, and probably others, would be glad of information.

It appears to me that there are very few people who are competent or in a position to write about the *practical* working of batteries, and these persons are certainly not central station engineers, who, as the majority readily admit, have a very superficial knowledge of the subject. The *technical* representatives of the various battery manufacturers, whose sole business is that of visiting and advising on the working of batteries, are the ones to whom we should look for information.

With regard to Mr. Pursey's letter, I may say that it is not so difficult to pick out sulphated positive plates or negatives with low capacity entirely by the way they gas, combined with their appearance and feel. A cell with sulphated plates gasses up very differently from one in which the positives are normal—the bubbles are smaller in size, the plates are usually lighter in colour and are hard to the touch. A cell in which the negative plates had small capacity would gas in a still different manner, the negative plates would probably gas long before the positives, and anyone with experience could tell by the look of the paste, and also by the colour of the plate on discharge, whether the negatives were likely to be at fault or not.

The loss of capacity of the negative plates is more often due to over discharge and internal short circuits than anything else.

I am very glad to see that "All Gassing" thoroughly appreciates the importance of gassing and the need of daily inspection; he has evidently been unfortunate in the choice of his battery as regards design, as I have seen many cells having none of the defects he mentions.

I am sorry to say that fully 50 per cent. of battery installations have no milker, and consequently whole cells have to be replated which might otherwise have been saved.

Electrolyte.

The discussion in your valuable journal on storage batteries is a most interesting one, and is of great value, not only to users, but to manufacturers of accumulators. In Mr. Abraham's article on his cell recorder, which appeared in your issue of September 18th, he tells us that his patent instrument will "record on paper the volts of a 280-cell battery within 13 minutes"—*i.e.*, 22 cells in one minute, which seems to me very quick work, especially to happen this side of the herring-pond.

I have been in charge of accumulators for some years, and my experience is that it is wise to very frequently take specific gravity readings and carefully compare them with previous readings, which is a very easy matter. Cells showing any particular difference—of course, taking into consideration the charging and discharging they have been subjected to—should be at once searched through, when, no doubt, the cause will be found.

I quite agree with Mr. H. S. Pursey's remarks. The writer under the *nom-de-plumè* "All Gassing," strikes a right chord in stating that end plates should have packing pieces between them and the boxes; also that cells should have more separators between the plates.

I should like to make the following suggestion to manufacturers of lead boxes—that some kind of plug should be fitted to the bottom, or in the sides close to the bottom, to enable the deposit to be easily cleared out. This is very essential, especially with batteries that have the plates burnt together.

Harry R. W.

Technical Instruction.

A short notice of "Appointments Vacant" of November 13th explains in a very pointed manner the reasons why our technical schools play such a small part in the development of our industries, and also why many firms have such a small opinion of their value and the commercial worth of the students they turn out:—

"Wanted—An electrical engineer for municipal power station, £400 a year; a tramway manager, £300, rising to £450; and an assistant to one of our leading technical schools *competent* to give instruction in the theory and practice of electrical machine design, £150."

This means that a man who has to assist in the education of our young engineers, and help them to stem the rising tide of foreign competition, has less than half the worth of a man who superintends the greasing of an engine or the punching of a tramway ticket.

Nearly every day we read of the opening of a new technical school, with a great flourish of trumpets, and after pretty speeches by the local "Bumbles," the classes commence. These schools cost £10,000 and upwards to build, but it is considered economical to entrust this or that department to a man at £100 to £200 a year, and as a result, instead of obtaining what we want, experienced engineers as instructors, we get probably a young man prize student of another technical school, who can test a machine to six places of decimals and draw pretty pictures in blue and green chalk in his note books, but with absolutely no experience of practical work. It is a rule on the Continent that all professors and assistants must have experience of practical work, and must have held responsible positions, and the committees of management find that it *pays* to offer sufficient salaries to attract good men, and then give them opportunities of taking up consulting work, thereby keeping not only themselves, but also their students up to date.

In some of our schools the mechanical instruction and design is that of the sixties, and it will continue to be so, until the educational authorities realise not only that one must spend money on buildings and apparatus, but that it will be thrown away, unless competent men are engaged as teachers.

T. R.

[We are entirely in accord with our correspondent as regards the ridiculous salaries paid to technical instructors, with the inevitable result that their numbers are continually replenished in the lower positions from the ranks of "clever students," destitute of practical experience and utterly untrained in teaching; as these attain to higher positions, they, like their predecessors, realise that they can command higher salaries, with better prospects, in practical work, and they leave the teaching profession at the first opportunity. It is a capital system—for these clever students, who derive immense benefit from the facilities for the acquisition of skill and knowledge which thus become available to them; but the ordinary students could tell a different tale.

We deprecate, however, the suggestion that a power station engineer has nothing to do but superintend greasers, or that a tramway manager supervises the punching of tickets; in this our correspondent carries his eloquent protest to an unnecessary extreme, for there was no need of disparaging highly responsible officials in order to establish his point. —Eds. Elec. Rev.]

Variable Speed Continuous-Current Motors.

The short article which appeared in the Review last week on the above subject, by Mr. Frank Broadbent, an old friend and late colleague of the writer of this letter, is interesting and instructive.

In the writer's opinion, however, he hardly places sufficient value on the obtaining of a very wide range of speed for motors which are used in the driving of machine tools. While the complication and increased cost of some of the multiple voltage systems proposed by various American engineers for attaining this desirable object may render them unsuitable in

many cases, it is admitted by nearly all who have electrically-driven machine tools under their management—and aim at getting the maximum amount of work produced therefrom—that the greater the range of speed the better, provided the methods of varying the speed are simple and easily effected.

After an experience of 10 years or more with motor-driven machine tools, the writer believes that this point of variable speed is *the* most important advantage of motor driving.

For some classes of machines a ratio of 1 : 2 is amply sufficient, as Mr. Broadbent states, and motors capable of giving this range of speed satisfactorily by simply varying the exciting current were in use under the writer's charge nine years ago. Knowing the advantages derived from their use, he has gone further, and more recently used motors with a speed ratio of 1 : 4, by double-wound armatures with two commutators and field regulation combined. This, of course, necessitates making special motors, but the results fully justify the small extra cost, for many purposes ; for instance, with large lathes and boring mills, where the diameters of work to be operated on vary within very wide limits.

The writer would certainly advocate the laying down of a three-wire system for any new machine shop, or any old shop to be converted to electrical driving, and thus, by means of the two voltages, get the advantage of a speed ratio of 1 : 4 in combination with field regulation. For a works which already has an electrical installation with the ordinary one-voltage supply, and a large number of motors, it is an expensive matter to alter things to a two-voltage system, the best means then being the double-commutator motor for those machines where the wide speed range is most desirable, as described before.

The writer fully concurs with Mr. Broadbent that speed regulation by inserting variable resistance in the armature circuit is too uneconomical to be considered in the great majority of cases.

Geo. Ralph.

Newcastle-upon-Tyne,
November 14*th*, 1903.

The Greatest Electric Shock on Record.

It is, of course, with some scepticism that one reads of a man living after receiving a shock of 24,000 volts, at a periodicity of 60 cycles, but, as the article is further perused, one finds the man did not have the full 24,000 volts, or anything like it.

The explanation given by the correspondent, as to the reason of the blacksmith still living, does not seem to me to be in any way clear or correct. He says that, owing to the arcs, the current was reduced in volume, but I would suggest rather that the current was reduced in quantity.

The statement that arcs were present, proves that volts were dropped across them, thereby considerably reducing the volts dropped across the man.

Then, again, the man had been working for some five hours at top pressure, and, therefore, his skin and clothes would be damp ; these would shunt the major portion of the current, and so, even if as much as 4,000 volts were dropped across the man, probably not a milli-ampere would actually pass through his body.

F. C. K.

[Our correspondent, "F. C. K.," himself seems somewhat hazy on nomenclature. Neither "quantity" nor "volume" is correct, but rather the "strength" or "intensity" of the current. "Quantity" is applicable only to the integral of current strength with respect to time. We doubt whether the survival of the victim can be so readily accounted for as our correspondent supposes. His clothes would have to be very damp to possess the extremely low resistance suggested, and the moisture would be very quickly evaporated. Moreover, the man's body was burned at the points of entrance and exit of the current.—Eds. Elec. Rev.]

The Parallel Running of Alternators.

One or two points in Mr. Leake's article on this subject in your issue of to-day call for notice.

First, as regards his objection to my use of the word "unloaded" when stating the practical rule for angular deviation, I agree that in my endeavours to be short, I have, perhaps, sacrificed clearness. What I should have said was that according to the "practical rule," the angular deviation is limited to a certain fraction of the pole-pitch when the machine is disconnected from the bus-bars and running under any constant load. As a matter of fact, in most designs of engines the deviation will be biggest when the load is zero ; and, consequently, it is right to specify a maximum deviation for the machine unloaded, provided it is understood that it is electrically disconnected.

With reference to the effect of periodicity, Mr. Leake says that there is no theoretical reason for supposing that parallel running is facilitated by low frequency, and from the instance he gives, I take this to mean that two engines and dynamos having similar magnetic systems and equal fly-wheel capacity, and differing only in the fact that one has double the number of poles that the other has, may be expected to perform equally well as regards parallel running. I do not think that this is correct. Suppose that the two machines are magnetically and electrically similar—that is, that a section at right angles to the axis of a pair of poles and the corresponding bit of armature is similar in the two cases—then the change in the rate at which energy is delivered to the bus-bars by the machine, by reason of a deviation of one degree from uniform rotation, will be double in the case of the machine with the larger number of poles of what it is in the other machine. Consequently, provided that the angular deviation of the machine when coupled to the bus-bars, due to uneven turning moment, is the same as when the machines are disconnected, the low-frequency machine will, practically speaking, operate double as well as the high-frequency one ; and in order to make the latter work as well as the former, its fly-wheel capacity must be doubled. The proviso referred to is, as stated in the paper, fulfilled in most cases by reason of the fact that, owing to the heavy fly-wheels required to meet the specification, the natural period of oscillation of the alternator about a state of steady motion is long compared with the period of variation in turning moment. There can be no doubt that, whatever may be said against it on other grounds, the practical rule is perfectly right in making the admissible angular deviation depend on the pitch angle and, therefore, generally speaking, on the frequency.

Mr. Leake asks my views on the subject of frequency in relation to free oscillations. Free oscillations have been very little studied in practice, and I, personally, have only been able to investigate them thoroughly in one case. One must, therefore, rely to some extent on theory. The effect of frequency is somewhat complicated, and is too long for statement here, but the formulæ from which it can be arrived at may be found in my paper on the subject (*Royal Soc. Proc.*, June 16th, 1903).

B. Hopkinson.

London, S.W., *November* 16*th*, 1903.

Steam Turbo-Generators.

Referring to my letter to you of November 10th, I have to thank you for correcting the figures for vacuum, which, unfortunately, the typist had transposed from the manuscript to the letter sent you.

John H. Barker.

Loughborough, *November* 16*th*, 1903.

Mr. Geo. Wilkinson's experience with reciprocating steam engines, as I gather from his letter published in your last issue, appears to have been unhappy. While one can be sorry for him, his conclusions are really too hasty to be passed without remark. There is at least one electricity works where steam, superheated very considerably more than 60° F., has been in regular use for the past five years in quick-revolution reciprocating engines. The engineers running the plant are quite happy about it, and would be glad to get the steam at a higher temperature if the superheaters would only give it. There has not been an accident in the five years due to the use of superheated steam, other than the failure of a copper bend inadvertently left in the main steam pipe when the use of saturated steam was discarded. Valve faces, cylinder liners, piston rods, &c., that have been subjected to superheated steam for five years are still in excellent condition, and the cost of engine repairs will compare favourably with that of most undertakings

using the same type of plant. During the whole of this period the cylinder oil used has not cost more than 1s. 10d. per gallon delivered at the works, and the quantity used is strictly moderate.

There seems generally to be considerably more fear of superheated steam among engineers in charge of steam engines than there is any occasion for.

E. Ll. I.

Bournemouth, *November 14th*, 1903.

BUSINESS NOTES.

Electrical Wares Exported.

Week ending Nov. 18th, 1902.		Week ending Nov. 17th, 1903.	
Adelaide	Value £219	Adelaide	Value £22
Amsterdam	60	Alexandria	176
Antwerp	60	Amsterdam	85
Auckland	77	Brisbane	12
Bangkok	80	Buenos Ayres	215
Beira	490	Calcutta	285
Bombay	179	Colombo	70
Bremen. Teleg. mat.	48	Durban	262
Calcutta	899	East London	440
Cape Town	43	Flushing	72
,, Teleg. wire	145	Fremantle	189
Chinde	10	Gibraltar. Teleg. cable	742
Christchurch	86	Hamburg. Teleg. mat.	326
Colombo	165	Hong Kong	38
Copenhagen	33	Madras	57
,, Teleg. wire	75	Melbourne	62
Durban	402	,, Teleg. cable	630
,, Teleg. cable	175	Otago	22
,, Elec. cable	1,375	Penang	572
East London	34	Port Elizabeth	24
Fiji	56	St. Petersburg. Teleg. wire	108
Fremantle	720	Shanghai	26
,, Teleg. mat.	69	Singapore	34
Gothenburg. Teleg. wire	32	Stockholm. Teleg. wire	135
Hamburg. Teleg. mat.	100	Sydney	167
Hamilton	165	,, Teleg. mat.	32
Hobart	20	Tientsin	85
Hong Hong	93	Trinidad	40
Lyttelton	105	Wellington	1,152
Madras	77	Yokohama	41
Marseilles	55		
Melbourne	281		
New York	47		
Paris	21		
Perth	1,840		
Port Elizabeth	532		
Reval	328		
Rotterdam. Teleg. wire	83		
Shanghai	47		
Singapore	44		
Sydney	796		
,, Teleg. cable	152		
Tokio	44		
Total	£10,262	Total	£6,071

Foreign Goods Transhipped.

Flushing. Elec. appar. Value £175 | Sydney. Elec. lamps .. Value £22

Bright's Trustees v. Parsons.—In the Chancery Division of the High Court, on Tuesday, 17th inst., the case of Bright's Trustees *v.* Parsons and others came before Mr. Justice Farwell.

Mr. A. P. Van Neck explained that the action was brought to recover certain shares, part of the property of the bankrupt, and the motion came on against Parsons and other defendants in default of defence. It was a complicated story, but it appeared that in the early part of 1900 Charles Bright was the beneficial owner of 560 fully-paid deferred shares and the registered holder of other shares which stood in the names of four nominees. At the time the bankrupt was busily engaged in litigation, and judgment was signed against him for £5,000. The bankruptcy proceedings then ensued. The bankrupt devised a scheme, and part of it related to dealing with the shares in Charles Bright & Co., Ltd., of Buenos Ayres. The nominees, Arthur George Lewis, Ernest Ford, Frederick Stevens, and Arthur Perry, executed transfers of their shares, but the transfers had never been registered, and the shares still stood in their names. The result was that neither the defendant nor the nominees had any beneficial interest in the shares; they had always been the property of the bankrupt. Counsel asked for a declaration that the whole of the shares were the bankrupt's property and that the plaintiff was entitled to them; also for an order for rectification of the register, and for an injunction against the defendants restraining their dealing with the shares.

His Lordship: Has Parsons appeared?

Mr. Van Neck: No, my lord; but he has been properly served, out of the jurisdiction.

His Lordship gave judgment as asked.

Otis Elevators.—The new Savoy Hotel extensions will be equipped with 19 "Otis" electric elevators. The installation is to comprise five powerful passenger elevators, four luggage elevators, and ten service elevators; all are electric with Otis controllers, and with the exception of two or three smaller short rise ones, the speed of the elevators will range from 250 ft. to 300 ft. per minute and upwards. Regard being had to the speed and lifting capacity, the hotel, as a whole when complete, will have (counting the eight "Otis" hydraulic elevators in the existing buildings) one of the largest hotel elevator installations in this country.

Catalogues and Lists.—An excellent catalogue of some 180 pages has been issued by Messrs. David Brown & Sons, Ltd., of Park Gear Works, Lockwood, Huddersfield, in which numerous illustrations, and much descriptive and tabulated matter are published respecting their machine cut gearing. Spur, bevel, worm, rawhide, screw and spiral gearing are included, together with certain information for determining the dimensions of different kinds of gearing.

Pamphlet No. 1,021 of the Union Electric Co., Ltd., shows a range of Union "A. P." type dynamos and motors from 100 to 500 h.p. at the usual standard voltages, which the company is placing before the trade. The machines are made in a large range of speeds; each size of magnet frame and armature can be completed in five different mechanical outfits, the simplest being suitable for forcing on to the engine, pump, or other shaft, and the most complete being that with three bearings mounted on a box bedplate and arranged for either rope or belt driving. The armature windings consist all of shaped bars sunk in accurately fitted and smooth surfaced slots in the cores. This type of machine is claimed to allow for ample ventilation and large output weight for weight.

The British Thomson-Houston Co.'s latest pamphlets are:—No. 160, detailing and well illustrating their various electrical measuring instruments for switchboard and portable use; No. 161 showing and describing their type K single-phase integrating induction wattmeters, which were recently explained in the Electrical Review (p. 747).

A list of the Vulcan watt-hour prepayment meter has been issued by Messrs. Geipel & Lange, of Westminster.

"Westrumite, the Disinfectant Dustlayer," is the title of a pamphlet brought out by the London and District Westrumite Co., Ltd., of Dacre House, Victoria Street, S.W. Special attention is directed to the qualities possessed by this material as a binding medium for making new macadamised roads. As it does not evaporate it is claimed to keep the road in a much better condition than when water is used, for a much longer time, preventing the formation of dust and mud. It is put on the road in an ordinary sprinkling cart, and is said to dry in about four hours.

Messrs. Alex. Wright & Co., of Westminster, have sent us a list relating to Simmance & Abady's new patent "Flicker" photometer, for conducting the most delicate tests of electric incandescent, arc, and other lighting. The forms illustrated are suitable for application to any existing photometer bar.

A brochure got up in the high-class style usual with Westinghouse publications, has been issued explaining in great detail, and by the aid of excellent illustrations, photographic and line, the principles and practice of the Westinghouse electro-pneumatic signalling system, manufactured by the Westinghouse Brake Co., Ltd., at King's Cross. One of the most interesting parts of the publication is the addendum which gives a short description and plan of the Bolton installation on the Lancashire and Yorkshire Railway, which was put into regular service for the control of passenger traffic in September, 1903.

The Edison & Swan United Electric Light Co, Ltd., have just issued three November leaflets detailing a number of their improvements in high voltage accessories for the present season. Leaflet No. A 2,015 describes the "Ediswan" improved pattern knife switches, which are suitable for circuits up to 550 volts, and are listed in six sizes for single, double and triple-pole, and also for single and double as change-over switches. Every part is standardised and interchangeable, and the six-page leaflet includes plans and tables of dimensions. Leaflet No. A 2,016 shows a strongly-made high-voltage pear switch, and leaflet No. A. 2,017 a new high-voltage wallsocket. Both of these articles have been specially designed with a view to securing absolute reliability on high-voltage circuits, and they can be easily wired. Members of the wiring trade can obtain copies of these leaflets on application to the company.

The Electric Heating Corporation, of 34, Leadenhall Street, E.C., has issued a small pamphlet relating to the Phœnix patent electric heating apparatus, of which it is the sole manufacturer. Illustrations of a number of neat designs are shown, with prices in some cases. The corporation has in preparation a list of cooking apparatus, hot plates, irons, foot warmers, &c.

The Vulcan Prepayment Meter.—Messrs. Geipel and Lange inform us that they have now adapted their Vulcan prepayment meter—which is largely used as a penny-in-the-slot meter—for use with shilling prepayments. The shilling-in-the-slot meter embodies all the features of the penny-in-the-slot, differing only in the size of the coin-slot and in the reduction of the numerator train. The meters are made in 2 and 3-ampere sizes, suitable for pressures between 50 and 250 volts, and provision is made for a prepayment at one time of 8s., while the price per unit can be varied to suit any limit in this country. Like the penny-in-the-slot Vulcan type, this meter may be used at will on either continuous or alternating current, and without requiring recalibration. It is claimed that the accuracy of this instrument is not only to Board of Trade requirements, but that it is within 2½ per cent. on the first 8-c.p. lamp. Inasmuch as the commutator is made of platinum, this accuracy may be relied upon even in towns where the atmosphere is apt to tarnish or blacken commutators made of oxidisable metals. We understand that this meter is in use in nearly 100 supply stations in this country, which alone speaks for its merits.

Foster Arc Lamps.—Messrs. Foster & Co., of Wimbledon, have secured the order for the lighting of Messrs. MacFarlane, Lang & Co.'s new biscuit works at Fulham, with over 70 of their latest pattern hot-wire factory arc lamps, which we described in the Electrical Review for July 31st.

The Gate Sawing Machine.—The machine shown in the accompanying illustration is intended for sawing the "gits" of brass and other castings, and it is made by Messrs. Edward G. Herbert, Ltd., of Cornbrook Park Works, Manchester. The general idea of the machine is sufficiently explained by the illustration. The "git" to be cut is rested in the angle of the bar support, and the operator, who has both hands free to hold the castings, presses the foot lever by means of which the machine is started and the saw is fed through the "git." The feed of the saw is a gravity feed, which can be checked, but not accelerated, by the operator, who cannot jam the saw in the work. The saws are hard, of special

Gate Sawing Machine.

make, and will cut the harder alloys of copper, and also Delta metal and aluminium. With the machine "gits" can be rapidly cut off flush with the casting, without fear of damaging the latter. "Gits" up to 1½ in. diameter can be dealt with at one cut, and larger sizes can be severed by two or more cuts. An important feature claimed by the makers is that the saw stops running as soon as the treadle is released. The machine should prove of great value, especially to brassfounders.

London Artesian Wells.—It has been further demonstrated, by the success obtained in boring for water at the new offices now in course of erection for the Royal London Friendly Society, Finsbury Square, E.C., that the water supply from the chalk beds underlying London is not only inexhaustible but perfect in quality. Messrs. Alfred Williams & Co., of Artesian Works, Bow, E., have just obtained from a 6-in. internal diameter steel-lined artesian well (450 ft.) a supply of over 2,000 gallons per hour, which has been proved by analysis to be wholesome drinking water of high quality. Messrs. Williams are now fixing at the above a similar system of pumping plant to those they have installed at Salisbury House and other places in the City. It consists of a deep well pump, which is lowered down the bore-hole about 100 ft. below water level. The pump rods are accurately balanced and connected to worm gears running in oil bath and mounted on ball bearings. This arrangement is coupled direct to an electric motor, which is connected to the mains of the Electric Supply Co. The arrangement is very simple. No driving belt is required, and all that is necessary is to switch on the current, and the water is delivered into storage tanks situated on the roof, which, in this instance, will be about 90 ft. from ground level.

Rugby.—In a recent issue we mentioned that Messrs. Willans & Robinson, Ltd., of Rugby, were entering the automobile industry. It is now definitely announced that the Duryea Co., of Coventry, whose petrol motor-cars have hitherto been manufactured in the United States, will now build them in this country, and that the engines and principal machine parts of these cars will be the product of the Rugby works.

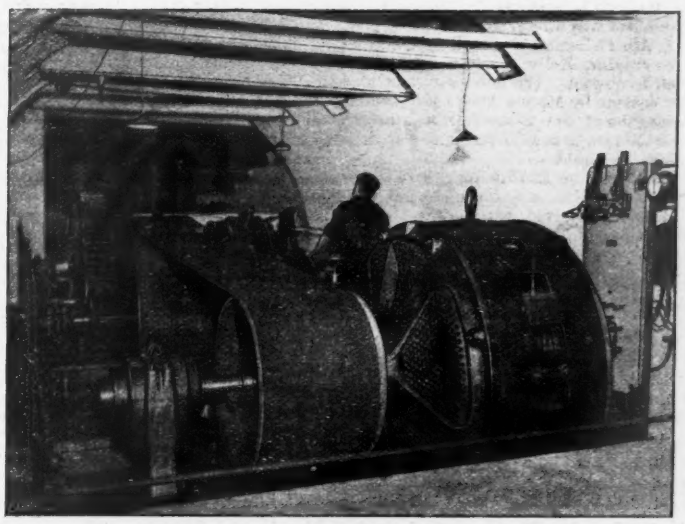
Auction Sale.—Messrs. Percy Huddleston & Co. will, on November 25th, offer for sale at Hammersmith a quantity of electrical plant, of which particulars appear among our advertisements to-day.

Books Received.—"Subject List of Works on the Mineral Industries and Allied Sciences in the Patent Office Library." London: The Patent Office, 1903. 6d.

"Cylinder Oil and Cylinder Lubrication," by H. M. Wells and W. Scott Taggart. Manchester: The Henry Wells Oil Co., 1903. 3s. 6d. net.

"Report on the Work of the Department of Technology of the City and Guilds of London Institute for the Session 1902-3." London: John Murray. 9d. net.

A Large Polyphase Hauling Plant.—The days of mule and horse haulage in underground mine workings are evidently numbered, judging by the increased employment of electrical energy for this purpose in coal and other mines. Improvement in output, with reduction in haulage cost, is mainly responsible for the introduction of electric hauling plants, in preference to either animal or mechanical haulage. An interesting example is that of the Bolsover Colliery, near Chesterfield, where a 200-H.P. endless rope hauling plant, operated by a polyphase induction motor of this output, is doing good service. The hauling plant is fixed in a chamber 360 yds. below ground level, where it is supplied with three-phase current at 440 volts by ·35 sq. in. paper-insulated armoured cable. The adjoining illustration shows the arrangement of the hauling motor and switchgear. The motor is coupled to the hauling gear by a 22-in



A Large Polyphase Hauling Plant.

cotton belt, running normally at a speed of 5,000 ft. per minute. The motor speed, which is constant, is 580 revolutions per minute, and a haulage rate of 194 ft. per minute is attained. 350 wagons at present comprise the load, with a constant number of 20 empties, the incline varying between 1 in 22 and 1 in 40. The motor, of the Westinghouse induction type, is controlled from a marble panel switchboard, fitted with voltmeter, circuit breakers, and starting switch. The latter operates in conjunction with two auto-transformers, which lower the line voltage for starting, the full pressure being applied when the switch is thrown to the running position. The plant is in constant operation for 16 hours a day. Electrical energy is derived from a 250-H.P. Westinghouse steam alternator and exciter, furnishing polyphase current at 440 volts, this unit being on the pit bank.

Provisional Order Notices.—The *London Gazette* for November 13th contained the following notices of applications for prov. orders:—

Northampton.—N.E.L. & P. Co., extension of area of supply.

Hexham.—E. P. Harvey, electrical engineer, Richmond, is to apply for lighting powers for this and other parishes (Northumberland).

Walmer.—U.D.C., prov. order.

West Ham.—Corporation tramways prov. order for short line from the Grove to the Broadway, Stratford.

Lancashire Electric Power Co. Removal of restrictions on erection of generating stations and other powers.

Royton.—U.D.C. Extension of tramway powers.

Clitheroe.—Corporation prov. order for electric lighting.

Leicestershire and Warwickshire Electric Power Co. Extension of time for commencing works, removal of restrictions *re* erection of stations and other powers.

London Electric Lighting Areas.—Board of Trade application to Parliament for alteration and adjustment of existing areas of supply in London.

Crompton.—U.D.C. Extension of tramway powers.

Ealing.—Corporation. Various powers including supply of energy to adjoining districts for lighting and traction supply of electric fittings, restricting use of overhead wires, &c.

Bankruptcy Proceedings.—Last week, at the Court of Bankruptcy, Mr. Registrar Hope conducted the public examination of Ferdinand Fanta, who is described as of 4 and 5, Warwick Court, High Holborn, engineer. His statement of affairs showed liabilities £5,194, of which £2,778 was unsecured, and an estimated surplus in assets of £1,826. The debtor stated, in reply to the Assistant Receiver, that in 1896 he patented an electric glow lamp, and in 1900 he also patented a process for cleaning and renewing electric lamps. He had acted as a director of companies formed to acquire the foreign rights, and he attributed his failure principally to inability to realise his interests in one of the patents, and to other causes.—The examination was concluded.

A receiving order has been made on a creditor's petition against George Neale, electrician, of Fulham Palace Road (lately trading with another as the South-Western Electrical Contracting and Maintenance Co.)

A second dividend of 2s. 8d. in the £ is payable on November 23rd at 7, Lothbury, E.C., in the case of Harry South & Co., Ltd.

Dissolutions and Liquidations.—The Automobile Supply Co., Ltd., is winding up voluntarily with Mr. J. E. Meadowcroft, 6, Moorgate Street, E.C., as liquidator.

The Centre Steering Tractive Co., of 47, Moorgate Street, E.C., is winding up voluntarily with Mr. F. W. Brown, 85, Culverley Road, Bromley Road, Catford, as liquidator.

Messrs. E. T., E. S., and W. H. Mackrill (E. T. Mackrill & Sons, electrical engineers, Aylesbury) have dissolved partnership so far as E. T. Mackrill is concerned. The remaining partners continue the business and will attend to debts.

Mr. Albert Lester Taylor has retired from the firm of Messrs. Lester Taylor, Kelly & Hide, consulting engineers, of 36, Dale Street, Liverpool. The business will be continued under the style of Kelly & Hide by Messrs. Archie Kelly and Walter James Hide.

A meeting of the Electric Royalties Syndicate will be held on December 18th to hear an account of the liquidation from Mr. W. H. Darvell, the liquidator.

Messrs. Haydn T. Harrison, P. J. Brewer, and F. S. Pilleau (Haydn, Harrison and Co., electrical engineers, Victoria Street, S.W.) have dissolved partnership. Messrs. Harrison and Brewer will continue the business.

Trade Announcement.—Owing to need of larger premises, Messrs. Van Raden & Co., Ltd., removed on November 1st to 567, Foleshill Road, Coventry.

Exports of Electrical Machinery.—The value of the exports of British electrical machinery during the past month is officially returned at £38,459, which brings the total for the ten months ending with October up to £370,281.

Telegraph Wire Imports.—The value of the imports into this country of foreign telegraph cable and apparatus connected therewith imported into this country during the past month is returned at £5,419, which brings the total for the ten months ending with October up to £50,199.

German Exports of Electrical Machinery.—A steady increase is taking place in the exportation of electrical machinery. For the eight months ending with August last the Customs returns showed a total of 8,580 tons, as compared with only 8,388 tons in the corresponding eight months of 1902.

Greenhouse and others v. South Lancashire Electric Traction and Power Co.—At the Chancery Court, held at Liverpool on 16th inst., before Vice-Chancellor Hall, this case was heard, Sir William Forwood and Mr. William Barrett, trustees for the debenture holders, being also made defendants. The action was by certain debenture holders to obtain a decision as to whether a majority were able to carry, as against a minority, a resolution which reduced the present first debenture holders to the position of second debenture holders by giving the company power to issue debentures to the amount of £600,000 and place them in front of the present debentures. An injunction was also asked for to prevent the trustees or directors acting upon the resolutions, and for the appointment of a receiver and manager.

Mr. Grant, for the plaintiffs, argued that the system had been built with the debenture holders' money, and that it was not reasonable to ask them to forego their priority and take the position of unsecured creditors of the company.

The Vice-Chancellor pointed out that it was clear the terms of the deed gave a three-fourths majority the power to sanction any modification or scheme of arrangement, although it partly deprived the debenture holders of their security. It might seem very hard to put £600,000 in front of the existing first mortgage holders, but persons who invested in the hope of getting 4½ per cent. on the faith of a deed which said that their rights might be compromised or modified by a majority of the shareholders could not come to the Court and claim those absolute rights which an ordinary mortgage gave. They decided that they should be postponed to an extent not exceeding £800,000, and this decision was come to by a majority of about 18 to 1 in value. It seemed to him, therefore, that the application failed.

ELECTRIC LIGHT AND POWER NOTES.

Ashford (Kent).—Messrs. Crossland & Frippard have notified to the T.C. their intention to float a company to apply for a prov. order for the lighting of the district. The Council has closed with the terms offered.

Bridgend.—Terms have been arrived at between the U.D.C. and the South Wales Electrical Power Distribution Co., for the supply of energy to the town. The company, in consideration of being able to supply consumers, undertakes not to charge ½d. for transforming, and to pay to the Council 2½ per cent. on the gross estimated sum receivable from all future customers for both power and light. The arrangement is for a year only.

Brynmawr.—The U.D.C. has decided to apply for a prov. order for electric lighting throughout the urban district.

Caerphilly.—The canvass on the electric lighting question undertaken by the U.D.C., has resulted in consumers for 1,000 8-c.p. lamps being secured in Caerphilly Town; 498 lamps in Aber and Senghenydd; and 307 lamps in Llanbradach. It is proposed to charge 6d. per unit in the Caerphilly district, where gas is 5s. per 1,000 ft.

Clitheroe.—The T.C. has decided to apply to the B. of T. for a prov. order, authorising it to supply electricity within the borough.

Coombe and Malden.—The U.D.C. has decided to apply to the B. of T. for a prov. order for E.L. within the urban district.

Darlington.—The T.C. has fixed the charge for energy supplied to the tramways at 1¾d. per unit.

Dunfermline.—The National Electric Construction Co. has intimated to the T.C. that it intends to apply for an order for the lighting of the district.

Dundee.—A scheme is under consideration to provide electrical energy for the mills and factories in the district, and it is proposed to form a company to carry it out.

Durham.—The C.C. has appointed a Committee to report upon a scheme of electric lighting for the county.

Egremont.—The B. of T. has communicated with the U.D.C. as to whether the electric lighting order obtained in 1900 shall be allowed to remain any longer in force. The Council is negotiating for the lease of the order to a private company, and has decided to apply for an extension of time.

Falkirk.—The electric light has been introduced at the gas works, in the purifying house, the benzole house, and other places where there is danger in using naked lights.

The T.C. has resolved to apply to the Secretary for Scotland for permission to borrow a further sum of £10,000 for electrical purposes. The expenditure on the undertaking up to the present time amounts to £24,500.

Faversham.—The T.C. has fixed the following scale of charges for the supply of energy:—Private lighting, 6d. per unit; small motors, 6d.; motors over 2 H.P., 3d.; meter rents, 1s. per quarter up to 25 8-c.p.; and 1s. 6d. per quarter up to 50 8-c.p. lamps.

Festiniog.—The U.D.C. last week discussed the question of the defective supply of energy by the Yale Electric Power Co, who had signed an agreement with the Council to supply the district. The special committee appointed to inquire into the matter stated that in view of the unsatisfactory supply of energy and the failure of the company to carry out the terms of the agreement, it recommends that a notice be served upon the company to the effect that unless the company carry out the general terms of their agreement with the Council, a notice shall be served upon them to terminate the same. The report was adopted, and the Council also decided to engage an expert to advise them on the subject.

France.—A company has been formed to take over a concession from the St. Gengoux Municipal Council for installing the electric light into the towns of Clermont-Ferraud, Pontgibaud, Pontaumur and Auzances.

The French Thomson-Houston Co. has been authorised to construct at Thillières, near Mouleydier, a flume for the utilisation of the waters of the River Dordogne for the purpose of generating electrical energy to supply the Bordeaux tramways, and to light the localities along the banks of the Dordogne.

Frome.—The U.D.C. has agreed to Messrs. Edmundson's Electricity Corporation taking over its electric lighting order, and has decided to allow them the use of the waste water from the baths during seven months of the year, and charge them for water supplied during the remainder of the period from the mains at 1d. per 1,000 gallons. An agreement is to be prepared embodying this arrangement, and containing a clause that if at any time during the continuance of the arrangement it should be found that, owing to the increased cost in fuel, or wages, or other expenditure, the water could not be lifted to the reservoir at less than 1d. per 1,000 gallons, the charge should be proportionately increased for the time being. Messrs. Edmundson's have decided to supply energy for lighting all premises owned by the Council at a flat rate of 2½d. per unit, the same as for public lighting. Energy for power purposes will be supplied at a reduction of 10 per cent. on its standard rate or at a flat rate of 1½d. per unit, at the option of the Council.

The U.D.C. has applied for a loan of £7,100 for electric lighting purposes, the money being required for extensions of the cables and for the provision of a cooling tower.

Gellygaer.—At a recent meeting of the U.D.C. it was decided to ask the Dowlais Co. to supply energy for the lighting of Bedlinog.

Germany.—H.M. Consul General at Berlin, in a recent report, states that favourable results have been obtained by the introduction of electric power into the weaving industry at Anrath, a Rhenish town. Formerly cottage hand weaving was extensively, though not very profitably, carried on. Since electric power has been introduced the weavers, who still work in their homes, are much better off. The average price of a loom is £40, and the electric power per loom amounts to about £3 per annum. In addition to a much higher productive capacity, the new system requires less exertion on the part of the operator, and is a decided gain from a sanitary point of view. A single loom enables a workman to earn upwards of £1 10s. a week, and some weavers frequently work two looms.

Tenders are about to be invited for the erection of an electric lighting station in the town of Peine (Hanover).

Gosport.—The B. of T. has threatened to revoke the Council's electric lighting order. The Portsmouth Corporation now has the work in hand.

Hollingbourne.—The Kent Electric Power Syndicate has informed the R.D.C. that it does not propose to proceed any further this session with the application for a prov. order to supply electricity in the Council's area.

King William's Town (S.A.).—The electricity works of the King Electric Co. were inaugurated on the 24th ult. A concession was granted by the T.C. to the company in 1900 for 25 years, the Council having the option of taking over the scheme by paying the shareholders 6 per cent. on the capital invested. The plant is single-phase alternating, at 2,100 volts, transformed down to 220 volts, in nine transformer sub-stations. The power station is equipped with two Paxman "Economic" boilers of 6,000 lbs. water evaporative capacity per hour, with a working pressure of 140 lbs. per sq. in.; two Belliss & Morcom engines coupled to E.C.C. 50-KW. alternators, and two direct-coupled exciters; Wheeler condenser and feed pumps; switchboard by Messrs. Cowans, Ltd.; and steam piping by Babcock & Wilcox, Ltd. The mains were supplied by Messrs. W. T. Glover & Co., and the transformers by Messrs. Ferranti, Ltd. Owing to the demand for private supply, arrangements are being made for the installing in the near future of another generating set and boiler. At the present time 225 25-C.P. lamps are in use for street lighting, and about 100 private consumers will shortly be taking a supply. The power station is situated on the banks of the Buffalo River, where there is a good supply of water. The cost of the scheme up to date is £18,000. The price of energy for street lighting is 7d. per unit, and for private consumers 1s. 3d. The whole of the work has been carried out under the superintendence of Mr. E. G. Clifford Jones, late city electrical engineer at Cape Town. The resident engineer is Mr. G. E. Saunders, who left the Hampstead Corporation to take up this position, last February.

London.—ISLINGTON.—The L.C.C. has given its consent to the B.C. to borrow £3,753 for the purchase of electricity meters.

BERMONDSEY.—At the last meeting of the B.C. a letter was read from the Surrey Commercial Dock Co., consenting to electric cables being carried through their premises and across the Surrey Docks.

Louth.—The T.C. has decided to assent to the offer of the Sir Hiram Maxim Electrical and Engineering Co. for the leasing of the Council's E.L. order. The company will repay to the Council the cost of obtaining the order, and will give the Council the opportunity to purchase the undertaking at the expiration of 14 years and every 7 years afterwards; energy is to be supplied at 6d. per unit for private lighting; 4d. for public lighting; and 3d. for power purposes.

Lowestoft.—The T.C. has declined to adopt a free wiring scheme submitted by Messrs. Mann & Co., of this town. It has been decided to give consumers the option of a flat rate of 6d. per unit, instead of the present maximum demand system of 7d. and 3d.

Melksham.—A prov. order for E.L. will be applied for in the next session of Parliament by the U.D.C.

Mirfield.—The Yorkshire Electrical Power Co. has intimated to the U.D.C. that it will be prepared to supply energy to the Council for distribution, by December 1st, 1904.

Mondariz, Spain.—An order has been granted to an appropriation of 6,000 litres of water per second from the River Tea for generating electricity for industrial purposes.

Pembroke, Co. Dublin.—The U.D.C. has resolved to apply to the L.G.B. for sanction to borrow £20,000 for extending its electric lighting system. It was stated at the meeting last week that the undertaking was very satisfactory, there being about £500 to the good.

Port Elizabeth (S.A.).—An extension of the electricity works is in contemplation, and it is proposed to call for tenders shortly.

Penzance.—Mr. W. T. Pressland, on behalf of the Penzance and District Electric Supply Co., has intimated to the T.C. that the company intends applying for a prov. order to supply energy in the district; the T.C. resolved to support Mr. Pressland.

Rotherham.—The T.C. has decided to promote a Bill in Parliament authorising it to sell and hire out electrical fittings and apparatus for lighting and motive power and to undertake the wiring of premises.

Saffron Walden.—The report of a special Committee recommending the installation of electricity for the whole of the town, has been adopted by the T.C., and a prov. order is to be applied for.

Sherborne.—The Southern District Electricity Corporation has given notice to the T.C. that it intends to apply for a prov. order to supply electricity to the district. The corporation stated that the price of energy would be to the Council 4d. and 2½d. for lighting and power respectively, and for private consumers 6d. and 3d., with an alternative on the maximum demand system, to the Council, first 100 hours, 7d., after 3d., for lighting; for power, 4d. and 2d.; and for private purposes, 7d. and 4d. for lighting; power, 4d. and 2d. The Council would have the right to purchase the undertaking at stated intervals.

Seaford.—The U.D.C. has declined to entertain the proposals for the supply of electricity, made by the Sir Hiram Maxim Electrical and Engineering Co.

Southend.—The T.C. has received permission from the L.G.B. to raise a loan of £20,000 for the purchase of additional plant for the electricity works.

Spain.—La Sociedad Alpujarrena de Nuestra Senora del Martirio has applied for a concession to utilise the water-power of the River Pincena in the generation of electrical energy for lighting and power purposes at Pincena.

Sutton.—The U.D.C. has determined to appoint a deputation to wait on the County of Surrey Electrical Power Distribution Co. in regard to the vibration from their works.

Swanage.—The Southern District Electricity Corporation and Messrs. Pressland & Frippard have made application for a prov. order to install the electric light in the town.

Swinton and Pendlebury.—The U.D.C. has decided to commence work under the E.L. order, and tenders for an electric lighting plant and cables are to be invited. Cables will be laid from Irlam's-o'-th'-Height along Manchester Road and Chorley Road to Swinton Church.

Sydney (N.S.W.).—The City Council, with a view to extending its plant in the near future, has instructed Messrs. Preece & Cardew to ascertain the terms on which Messrs. Dick, Kerr are prepared to supply an additional 1,000-H.P. steam alternator, with condensers, switchboards, &c., and 1,000-H.P. additional substation machinery, with the necessary additions to the switchboards.

Thames Ditton.—Messrs. Edmundson's Electricity Corporation has informed the U.D.C. that it will apply to the B. of T. for a prov. order for E.L., and the Council has decided to withhold its consent to the application.

Trowbridge.—The U.D.C. has received notice of the intention of the Western Electric Distributing Co. to apply for a prov. order to supply electricity within its area. The Council already possesses its own order, but nothing has been done to carry it out, beyond obtaining an expert's report.

Todmorden.—A L.G.B. inquiry has been held in regard to the application by the T.C. to borrow £27,174, for a combined electricity and destructor works. There was no opposition.

Whitley Upper.—The U.D.C. is negotiating with the Yorkshire Electric Power Co. for the supply of electricity for power purposes in the district.

Wimborne.—The Southern District Electricity Corporation has notified the U.D.C. that it is applying to the B. of T. for a prov. order for the lighting of its area. The Council has decided to take no steps in the matter.

Wishaw, N.B.—The T.C. has resolved to apply for a prov. order for electric lighting purposes. Energy is to be taken from the Clyde Valley Electrical Power Co., satisfactory terms having been arranged.

Wolverhampton.—The T.C. intends applying for powers to supply energy in bulk to local authorities and others outside the borough.

ELECTRIC TRACTION NOTES.

Bishop Auckland.—The local authorities have promised to support an application by a syndicate for powers to construct electric tramways from Bishop Auckland to Spennymoor, Eldon Lane, West Auckland and Etherley. Messrs. D. Balfour & Sons, of Newcastle, are the engineers for the undertaking.

Chatham.—At a meeting at the Queen's Hall, Chatham, Mr. W. Jensen, the esteemed resident engineer and manager of the Chatham and District Light Railways Co., stated that the total mileage run since starting had been 1,055,000; number of passengers carried, 9,500,000 (on one particular day they carried 53,000 people); one of the drivers had covered 27,500 miles, had worked a whole year without any accident, and had carried on his car over 200,000 people. This driver had received a bonus from the company as an appreciation of his conduct.

Crewe.—The T.C. has decided that until it has secured powers to construct electric tramways, it will not consider any proposals from companies for the provison of electric tramways. Two companies have submitted schemes for electric tramways from the town to Nantwich.

Dartford.—The U.D.C. has come to the conclusion that it is desirable that the construction of electric tramways in the town should be proceeded with forthwith, and a Committee has been appointed to consider the best method of exercising the powers possessed by the Council. The estimated cost of constructing the lines included in the order obtained in 1902, with the plant, is £90,713.

Glasgow District.—Intimation has been made of several large schemes of tramway extensions in the district of Glasgow. The Glasgow Corporation has the largest proposals. It has decided to apply to Parliament for the following extensions of its system:—A line from Maryhill to Milngavie, with a branch to Bearsden; from Pollokshaws (West) through Thornliebank to Spiers Bridge, and thence to Busby; from Cathcart to Clarkston; and from Pollokshaws (East) along Kilmarnock Road, to the new railway station at Whitecrangs. The T.C. is also considering the question of constructing a line from Thornliebank to Barrhead. The Clyde Valley Electric Power Co. are also in the field, and they propose to seek powers for the construction of tramways to Bearsden and to Milngavie and to Thornliebank and Nitshill. It is also stated that Mr. Murphy, who is at present constructing the lines in the Paisley district, contemplates applying for powers to extend the connection to Barrhead. The schemes are the largest that have been brought forward in the west of Scotland for some time.

Greenock.—Some mention was made in these columns recently of the arbitration proceedings between the Corporation and the Greenock and Port Glasgow Tramways Co. We now have some further facts respecting the matter. We understand that the agreement between the above parties stipulated that the company were to take from May 1st, 1901, all the energy required for the working of the tramways, the minimum amount guaranteed by the company being 500,000 units per annum. The price to be paid by the company for this energy was 1½d. per unit for the 500,000, the price of all energy in excess of this amount to be settled by mutual agreement. A further condition of the lease was that the company were to pay the Corporation a reasonable sum for the use of feeder ways. Owing to differences arising between the Corporation and the company, an appeal was made, as provided by the lease, by the company to the Board of Trade, who appointed Mr. Sheldon, barrister, to act as arbiter between the two parties. The questions submitted to him were:—

1. To determine the date from which the company were bound to fulfil their obligation to take electric energy from the Corporation at the rate of 500,000 units per annum.
2. The price to be paid by the company for all energy in excess of 500,000 units per annum.
3. The sum to be paid as rental for the use of cable-ways, the capital value of which was admitted to be £2,000.

The sittings of the Arbitration Court took place in the Inns of Court Hotel, Mr. Sydney Morse representing the company (which is one of the British Electric Traction group), while Mr. John Kennedy looked after the interests of the Corporation.

On the first question, the company claimed that the work of reconstructing the tramways was delayed on account of the action of the Corporation in making certain alterations to the original plans, and they further claimed that the Corporation were not in a position to supply energy at the date specified in the lease—viz., May 15th, 1901. The Corporation, on the other hand, denied that the alteration which they asked the company to make in their original plans had caused any real delay, and also stated that while the new plant which had been ordered for traction purposes was not ready till July 1st, they were prepared to give a supply from the existing plant which was identical with the plant ordered for traction. They therefore claimed from the company the sum of £741, which represented the difference between the energy actually taken by the company during the first year of the lease (381,000 units), and the minimum supply of 500,000.

The most important of the three questions was, of course, that referring to the price to be paid for the energy in excess of the 500,000 units.

The Corporation called Mr. J. A. Robertson, burgh electrical engineer, to give evidence as to the present condition of the undertaking, and costs of producing energy for the company. He was cross-examined at great length by Mr. Sydney Morse, who tried to show that the cost of producing traction energy in a combined station was much less than the cost of producing lighting energy, and that it was unfair to divide the costs of production equally over the whole output. The Corporation also called Mr. I. E. Winslow, who gave it as his opinion that no reduction should be made in the price charged for energy until the company's consumption reached a million units per annum. To rebut these witnesses' evidence, the company called Mr. H. M. Sayers, Mr. A. J. Lawson (of the B.E.T. Co.), Mr. Arthur Wright, of "maximum demand" fame, and Mr. Philip Dawson. These witnesses were all of opinion that the excess power should be supplied at the rate of ½d. per unit. As the company are taking energy at the rate of nearly 800,000 units per annum, it will be seen that the difference between the company's figures and the price asked by the Corporation would amount to over £1,200 per annum. The examination of various witnesses turned on such questions as the proportion of capital which ought to be allotted against traction plant in a combined station, the comparative cost of generating for traction and lighting purposes, the amount of overload which a traction generator should stand, and the "kick" of different types of recording instruments.

The arbiter's decision is as follows:—

1. August 1st, 1901, is the date from which the company were bound to take energy at the rate of 500,000 units per annum.

2. That seven-tenths of a penny is the price to be paid for all energy in excess of the minimum guaranteed amount of 500,000 units per annum.

3. That £125 per annum is the sum to be paid for the rent of the cable-ways used by the company for their traction feeders.

The Court sat on 10 different occasions between April 25th and July 29th. The costs of the arbitration are to borne in equal shares by each party.

London County Council.—The tramway question occupied the attention of the Council for nearly two hours on Tuesday, as the result of the presentation of a scheme in relation to the proposed purchase of the undertaking of the London Southern Tramways Co. It may be remembered that a fortnight ago the Council referred back to the Highways Committee for reconsideration a recommendation in favour of the powers of purchase not being exercised at the present time. The report upon which this recommendation was based stated that the tramways in question, which comprise a total length of 5¾ miles, and extend from Vauxhall to Camberwell and Norwood, are not at present remunerative, and that in order to make them profitable considerable portions of the lines would have to be doubled, and costly street widenings carried out. The cost of the street improvements, if the conduit system alone were used, would be extremely heavy, as it would be necessary to provide sufficient width for double lines throughout, and this would involve a serious excess of expenditure over receipts on working for several years. With the adoption of a mixed system of overhead and underground traction, and by avoiding the more expensive widenings, the excess cost of working could be considerably reduced; but the Committee doubted whether even then the system would be entirely self-supporting from the first. The total capital sum which would have to be provided was estimated at £450,000; and having regard to the present capital commitments of the Council, the Committee did not feel justified in recommending steps to be taken for the compulsory purchase of the undertaking.

The Highways Committee, having given the subject additional consideration, reported on Tuesday having had before them a further proposal of the overhead system on the lines between the Swan, Clapham Road, and Camberwell Green and Norwood respectively, and for the conduit method between the Swan and the terminus at Vauxhall. The total expenditure involved would amount to £375,000, of which £295,000 would be for the tramways, and it would be possible to arrange for a through service of cars from Tooting to Vauxhall, and ultimately over Vauxhall Bridge to Victoria Station. There was no doubt that a through service would be largely used, and it was considered that when reconstructed in that manner the lines would prove to be self-supporting. The Committee, therefore, recommended the Council (1) to convene a special meeting to consider and decide whether the company's undertaking should be purchased; and (2) to refer to the Highways and Improvements Committees to ascertain whether the local authorities concerned would consent to the adoption of the overhead system for the whole with the exception of the lines in South Lambeth Road, contribute one-third of the net cost of the necessary street widenings for the reconstruction of the tramways, and consent to the doubling of the tramways where decided upon.

Mr. J. W. Benn, chairman of the Committee, in moving the adoption of the first recommendation, stated that there had been some divergence of opinion in the Committee, but it had led to most happy results. The Council some time ago laid it down as a policy that for the centre of London it would have the conduit system, but that in the outlying districts suggestions for the overhead method should be borne in mind as occasion arose. In the case of the original proposal, the Committee came to the conclusion that it could not be submitted for acceptance by the Council. If the Council was to raise money in the City, schemes must be presented which would appeal to business men. The amended project showed a saving of £135,000 over the original scheme, which was estimated to cost £430,000. That case was important, because it would govern several others in London, as there were other straggling lines where it would for several years be impossible to instal the conduit, and where they must have the overhead system.

Lord Welby, chairman of the Finance Committee, opposed the recommendation in the course of a lengthy speech. He remarked that the financial demands on the Council were growing so much that they were outstripping the bounds of prudence, that the market was overstocked with high class securities, and that for some time to come the Council would have to pay very dear for the money it required. He emphasised the necessity for the exercise of prudence, and said that if the Council received a check on going into the money market the effect would be disastrous.

After a long discussion, the chairman of the Committee replied, and stated that the scheme as outlined was estimated to yield a profit of 7 per cent. on the expenditure, and provide an alternative route from Clapham Road *vid* Vauxhall to Westminster Bridge. On being put to the Council, the first recommendation was adopted by a large majority, and the second was also approved.

The Council subsequently decided without discussion to sanction an estimate of £90,000 for the purchase of rails, conductor tees and fastenings for the reconstruction of 22½ miles of the northern tramways, and £13,850 for the construction of new termini at Tooting.

As a result of not obtaining the consent of the road authorities or the promise of a contribution towards the cost of the street widenings, the Council resolved not to proceed with the proposed applications to Parliament for powers to construct the following lines:—(1) Southwark Street *vid* Stamford Street and York Road to Lambeth Palace Road; (2) Shepherd's Bush Road to the Marble Arch; (3) Battersea Park Road to King's Road, Chelsea; and (4) Tooting High Street to the new county boundary.

The Council adjourned for a week the consideration of a report by the Highways Committee proposing an expenditure of £35,000 for the rebuilding of car-sheds at Streatham. The report states that a scheme will be submitted at an early date for the conversion of the cable line to electric traction, together with a proposal for a sub-station at Streatham.

Manchester.—The Corporation, on the initiation of the Tramways Committee, will promote another tramway Bill in the coming session of Parliament. Powers are to be sought for the laying of lines in Parker Street and George Street, behind the infirmary; also along Victoria Avenue, between Rochdale Road and Middleton Road; along Mill Street, Ancoats, and along the newly-formed portion of Bradford Road. Powers will also be taken, amongst other things, to purchase lands and make street widenings within and beyond the City boundary in connection with the tramways. There is a clause in the Bill to empower the Corporation to construct tramways, with the approval of the local authorities concerned, in Sale, and as far as Altrincham and Dunham Massey. The application to Parliament was sanctioned by the City Council last week.

Nottingham.—The fog last week reduced the Corporation's tramway receipts by no less than £620, as compared with the takings in the previous week.

Preston.—A syndicate has informed the R.D.C. that they intend applying for powers to construct electric tramways between Preston and Blackburn.

Radcliffe.—The District Council is seeking further powers from Parliament respecting tramways, with the object of connecting the town with the adjacent boroughs of Bury and Whitefield. Power will also be sought for the supply of electricity for public and private use, and for street improvements in connection with the tramway undertaking.

Sunderland.—At the meeting of the T.C. on the 11th inst. a report was laid before the meeting signed by the heads of the Tramways Committee and the responsible officials (Mr. J. F. C. Snell, electrical engineer, and Mr. H. England, general manager of the tramways), as to the depreciation and renewals fund of the tramways. Of this the following details should prove interesting:—

—	Capital expended to March 31st, 1903.	Estimated life (years).	Percentage.	Annual amount to be set aside
Rails, fish-plates, sole-plates, tie-bars and bolts	£40,567	12	8	£3,248
Points and crossings	4,125	6	17	701
Excavating and concrete, &c.	25,619	30	2 1/6	537
Wood pavement	8,922	7	14⅓	1,372
Granite pavement	15,145	16	6	912
Whinstone and local setts pavement	19,206	12	8	1,536
Bonds	2,844	12	8	225
Booster	503	10	10	50
Poles and brackets	8,094	20	5	405
Excavation and concrete	593	30	2 1/6	13
Trolley-wire, guard-wire and fittings	3,189	8	12½	400
Frogs and crossings	61	3	33	20
Cabins	4,951	20	5	250
Conduit casing and boxes	6,630	30	2 1/6	139
Section boxes	591	30	2 1/6	13
Land, &c., for street improvement	100	50	2	2
Buildings " "	52	40	2½	2
	£141,186			
Car-bodies	£17,330	15	6⅔	1,142
Trucks	6,900	20	5	345
Motors and electrical equipment	15,364	20	5	770
	£39,594			
Purchase on undertaking; cost of Act, &c.	£47,035	30	2 1/6	987
Land and car-sheds	29,623	30	2 1/6	621
Tools and machinery	1,013	10	10	100
	£258,451	About	5½	£13,690

This worked out to £23,854 for the periods that the money had been expended and the tramways opened, being 5½ per cent. on £153,864, the amount expended for the 18 months to March 31st, 1902, and the same percentage on the total outlay of £223,541 for the year ending March 31st, 1903. The amount actually set aside was £27,426, and the cost of renewals to March 31st, 1903, had been £1,189, leaving £26,237 in hand. In the remarks that are intended to cover these figures it is stated that although the sum set aside is above the estimate given above, £5,000 has also been invested as a further reserve fund in accordance with the provisions of the Act, and they are now building up an accident reserve fund of £2,000, of which £911 3s. 9d. has been contributed during the last two years. The report was regarded as entirely satisfactory and was adopted, with the suggestion that it should be revised every three years.

Torquay.—Negotiations between the T.C. and the Dolter Electric Traction Co. for the construction of electric tramways in the town, have been re-opened.

Wallasey.—The U.D.C. has decided to promote an Act empowering the Council to extend the electric tramways to Wallasey and Poulton. The estimated cost of the work is £180,000.

Wardle.—At a special meeting of the U.D.C. on November 12th, it was decided to apply for a prov. order authorising the Council to construct electric tramways in the town, and to purchase the existing lines and electrically equip them.

Woking.—On November 11th the U.D.C. discussed the scheme of the West Surrey Light Railway Co. for providing a tramway system from Monument Road to Knaphill, and decided unanimously to support it. The cost is estimated at £15,000.

TELEGRAPH AND TELEPHONE NOTES.

Bournemouth Telephones.—If the N.T.C. does not grant the same terms to subscribers, as are in vogue at Portsmouth, the B.C. will canvass to feel the way toward municipal telephony.

German Submarine Cables.—The Consul-General of the United States at Frankfurt says in a recent report (which is quoted from the *Times*) that during the last seven years Germany has laid 7,375 miles of ocean cables, at a cost of about 1½ millions sterling. In 1898 a cable, 73 miles long, was laid between Sassnitz and Trelleborg; in 1898 German South-West Africa was connected with the existing cable system by a line 154 miles long; and in 1900 the first German-American cable was laid between Emden and New York, by the Azores, a distance of 4,813 miles. About the same time the first German cables along the Chinese coast were laid; one of these was from Tsing-tau (Kiao-chau) to Chifu, 285 miles long, and the second connected the former place with Shanghai and is 438 miles. In 1901 a fifth cable connecting Germany and England was laid, as well as a telephone cable from Fehmarn to Laland. A second German cable to New York by the Azores has been commenced and will be completed before the end of next year, while a line to Vigo, 1,300 miles in length, has been laid. Germany is also contemplating an extension of her cables by constructing lines between Alenado and Guam, in the Caroline Islands, and the Pelew Islands and Shanghai. "It is said," concludes the Consul-General, "that the growth of German interests, both military and commercial, will in future require the building of more cables by Germany, independent of foreign nations. Germany now has cable works and two cable steamers."

The Indian Telegraph Service.—The report of the Indian Telegraph Department for the year 1902-3 (which is abstracted in the *Times*), shows that the net loss on the reduction in the rates of cablegrams between India and Europe from 4s. to 2s. 6d. per word has been quite small in the first year of its operation, owing to the resulting increase in business. The foreign private message revenue only fell off by 3½ lakhs, and this was due not so much to the reduction in rates as to the diversion of the Australian traffic with Europe, formerly transmitted *via* India, to the direct cable route *via* South Africa. The total earnings of the department, 112½ lakhs of rupees, were slightly in advance of those of the previous year, and the net profit gave a return of 4·15 per cent. on the aggregate capital expenditure of over 795 lakhs. Throughout the Dependency there are 5,652 telegraph offices, 56,830 miles of lines and over 200,000 miles of wire. The Wheatstone automatic apparatus has proved invaluable in disposing of the traffic in times of pressure and prolonged interruptions of communication, and was of great assistance in connection with the work entailed on the department by the Delhi Durbar. A system of wireless telegraphy has been satisfactorily established between Saugor Island and the Sandheads, and there has been no difficulty in maintaining communications, except during thunderstorms.—Simultaneously with the publication of the report, the Government of India has notified the introduction of a revised inland tariff, reducing the charges for all three classes of messages—viz., "urgent," "ordinary" and "deferred," and also for Press messages. The new rate for "urgent" messages (16 words for two rupees) remains double that for "ordinary" ones, but they both take precedence in order of despatch over "deferred" wires. The *minimum* charge for the latter class has hitherto been eight annas (8d.), but is now reduced to four annas. Six words of address are allowed free, and four words of message can be sent for four annas, each additional word being charged an anna. Under this tariff telegrams can be sent over 2,000 miles at a *minimum* cost less by one-third than the corresponding charge for inland messages in this country.

The Magnetic Storm.—The Astronomical Society of France devoted its sitting of November 5th to the study of the magnetic disturbances of October 31st. M. Camille Flammarion, the celebrated savant, insisted on the connection of facts observed over the last 150 years, proving the Solar origin both of the Aurora Borealis and of these great magnetic disturbances. M. Bordelongue, Director of the Telegraph Department, cited two conclusive facts which complete the numerous unexpected discoveries made on October 31st last. All the cables running from Europe to Newfoundland were seriously affected. The French line alone, which runs direct from Brest to New York, transmitted its work with the

usual regularity. This remarkable immunity was not due to the construction of the line alone. It is known that at the sea bottom near Newfoundland there are immense masses of iron. These deposits are magnetised by the electric discharges of the sun, and this magnetisation, which is temporary and probably oscillatory, appears to be the cause of the induced currents which flow in the lines. The concensus of opinion was in favour of telluric currents as the cause of the recent disturbances, and the discussion turned on the nature of these currents.

Municipal Telephones.—On Saturday the Brighton municipal telephone, which has been extended to Burgess Hill, was inaugurated at the latter place, the chairman of the U.D.C. (Mr. A. P. Scrase, J.P.) making the first call to Brighton.

The Pacific Cable.—It is stated that the expenditure on the working up to March this year amounted to £120,000, and the revenue from the three months' working up to that date was £18,310. The deficiency, £101,690, will be apportioned as follows:—United Kingdom and Canada, £98,055 each; Victoria, New South Wales, Queensland, and New Zealand, £11,222 each. For the current year it is estimated there will be a deficiency of £92,100.

Spanish Telephones.—A telephone line is about to be erected between Madrid and Toledo. Arrangements are also in hand for the establishment of telephonic communication between Madrid and Burgos and between Madrid and Ciudad Real.

Telegraphic Interruptions and Repairs:—

Cables.	Interrupted.	Repaired.
Dominica-Martinique	May 5, 1903	
St. Lucia-Martinique	May 7, 1903	
Guadeloupe-Martinique	May 5, 1903	Nov. 16
Anjer-Kalianda	Aug. 2, 1902	
Cayenne-Pinheiro	Aug. 18, 1903	
St. Lucia-St. Vincent	Sept. 19, 1903	
Reissa-Issa (Yemen)-Camaran	Oct. 22, 1903	
Paramaribo-Cayenne	Feb. 26, 1903	
New York-Hayti	April 18, 1903	
Trinidad-Demerara No. 2	Oct. 22, 1903	Nov. 13
Trinidad-Demerara No. 1	Aug. 27, 1901	
Tourane-Amoy	Nov. 10, 1903	
Accra-Lagos	Nov. 14, 1903	
Lagos-Brass	Nov. 14, 1903	

Wireless Telegraphy.—A Reuter despatch from Rome, dated November 14th, says that experiments which have been made by the Italian naval authorities with a new system of radio-telegraphy originated by Prof. Alessandro Artom, have conclusively proved that the new system makes it possible to transmit electric waves in a given direction. It was found that the signals made were perfectly transmitted when the train of electric waves was directed towards the receiving station for which they were intended, and that as soon as it was turned in another direction the receipt of the signals ceased. It is contended that the solution of the problem of the dirigibility of electric waves thus obtained brings radio-telegraphy into the region of practical utility. The Minister of Marine has instructed Lieutenant Pullino, director of the wireless telegraph station of Monte Mario (Rome), to give every assistance in further experiments with the Artom system.

A Milan Press telegram reports that Signor Marconi has selected a site for the establishment of an extra-powerful wireless telegraph station for directly connecting Italy with the Argentine Republic.

Reuter reports that the work of constructing a wireless telegraph station at Bari is far advanced and will shortly be completed, so that the station may be opened to the public towards the end of the present year. This station will be able to communicate with the other stations established along the Italian coast, with vessels in the Adriatic, and with the Montenegrin station at Antivari, where the work of installation will be commenced in a day or two. The wireless telegraph stations at Maddalena, Monte Mario, near Rome, Palmaria and Cozzo Spadaro are already working. The first two are exclusively intended for military purposes; the other two will also be open to the public. Another station will be opened immediately at Santa Maria di Leuca. The site for the trans-Atlantic station has been definitely chosen at San Rossone, where the Villa Royale has been selected. This station is intended to communicate not only with Argentina, but also with the stations at Table Head (Canada), Cape Cod (United States) and Poldhu (Cornwall).

CONTRACTS OPEN AND CLOSED.

OPEN.

Brierley Hill.—The Technical School is to be wired for electric lighting, and tenders are to be invited from wiring firms.

Brighton.—December 7th. Six water-tube boilers, piping, tanks, and sundry other steam plant, for the Southwick power station. See "Official Notices" November 6th.

Ceylon.—December 1st. The Ceylon Government is inviting proposals from those willing to enter into a contract for the supply of electrical energy to the various offices, buildings, and premises of the Government. See this column for November 6th.

Crewe.—December 4th. Wiring the new municipal offices. See "Official Notices" to-day.

Dorchester.—November 26th. The Council is open to negotiate with companies willing to take over its electric lighting order. See "Official Notices" November 13th.

Dublin.—November 30th. Stores for the Dublin United Tramways Co. See "Official Notices" November 13th.

Great Western Railway.—December 7th. Water-tube boilers, engines, three-phase generators and auxiliary plant, for the Park Royal power station. See "Official Notices" November 6th.

Hornsey.—November 30th. Meters, indicators and fuse-boxes. See "Official Notices" November 6th.

Italy.—November 30th. The Municipality of Canosa di Puglia (Bari) are inviting tenders for the installation and working of an electric lighting station for public and private purposes in the town.

Kirkcaldy.—November 23rd. One 400-KW. steam engine and dynamo for lighting and traction. See "Official Notices" November 6th.

L.C.C.—December 8th. Electric wiring of five sub-stations and three tramway car-sheds. See "Official Notices" November 13th.

L.C.C.—December 8th. Four 3,000-KW. three-phase generators, with exciters, for the Greenwich tramway power station. See "Official Notices" November 13th.

L.C.C.—January 19th, 1904. Six electrically-driven three-throw boiler feed pumps for Greenwich power station. See "Official Notices" to-day.

Middlesbrough.—November 28th. One 600-KW. steam turbine dynamo; Lancashire boilers, condensing, and other plant. See "Official Notices" November 13th.

Newport.—November 23rd. Three 50-B.H.P. motors with switchgear for the Electricity Committee. See "Official Notices" November 13th.

Preston.—December 12th. Traction switchboard and accessories. See "Official Notices" November 13th.

Swindon.—November 23rd. Traction switchboard and feeder cables. See "Official Notices" November 6th.

Sydney (N.S.W.).—December 30th. Telegraph, telephone, and electric light material for the Deputy Postmaster-General of Sydney. See this column for November 6th.

Wednesbury.—November 20th. Electric wiring of public buildings. See "Official Notices" October 23rd.

Wimbledon.—December 8th. Water-softening and storage plant. See "Official Notices" to-day.

CLOSED.

Ashton-under-Lyne.—The T.C. has accepted the tender of Messrs. De Grelle Houdret & Co., for the supply of carbons for arc lamps.

Belfast.—We understand that the Irish Flax Spinning Co., of Belfast, have placed a contract with the British Thomson-Houston Co., for the electrical operation of the extensions to their mills now in course of erection. The contract comprises the provision of a 60-KW. three-phase generator, switchboard, and three motors for driving the various rooms in the mill, which contain the usual flax preparing and spinning machines. This is believed to be the pioneer scheme of electrical operation of flax machinery in Ireland.

Johannesburg Tramways.—A further extension contract has this week been placed with Hadfield's Steel Foundry Co., Sheffield, for manganese points and crossings.

Kingston-on-Thames.—The tender of the Schattner Electricity Co. for 500 demand indicators at £800 has been accepted by the T.C.

London.—The London County Council has accepted the tender of J. G. White & Co. to construct on the conduit system a portion of the tramway to be laid along St. John Street and St. John Street Road.

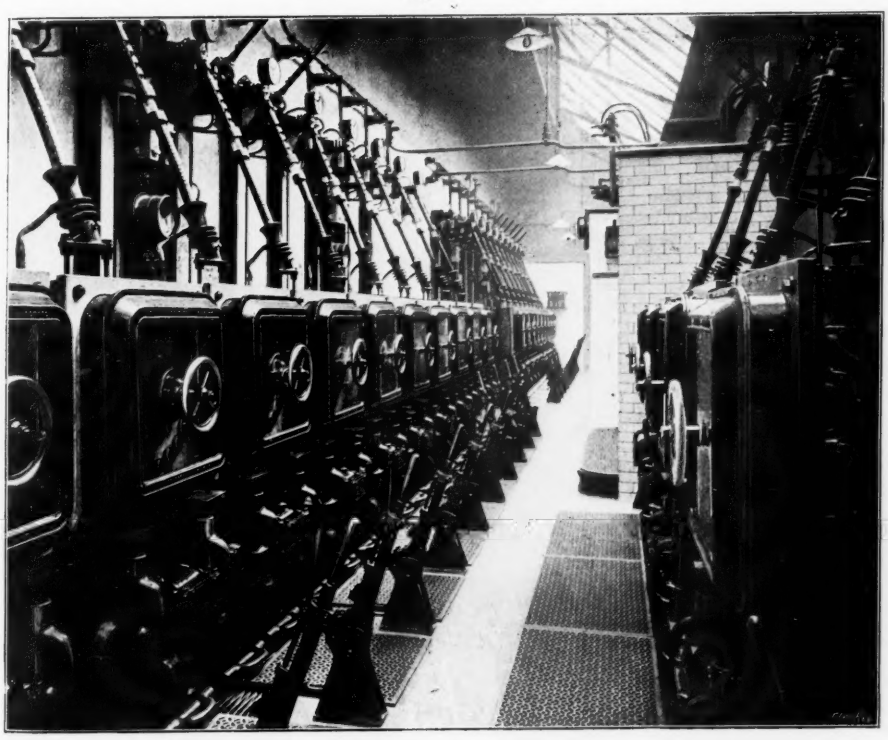
Northfleet.—A contract, including a complete installation for electric lighting and power, arc lamps, pumping plant, &c., with all necessary wiring, for Messrs. Tolhurst & Son's cement works at Northfleet, Kent, has been placed with the British Westinghouse Co.

Whitehaven.—The T.C. has accepted the tender of the British Insulated Co. for the supply of armoured cable, and that of Callender's Cable & Construction Co. for 2,500 yds. of cable.

RECENT DEVELOPMENTS OF THE METROPOLITAN ELECTRIC SUPPLY CO.'S INSTALLATIONS.

(*Concluded from page* 787.)

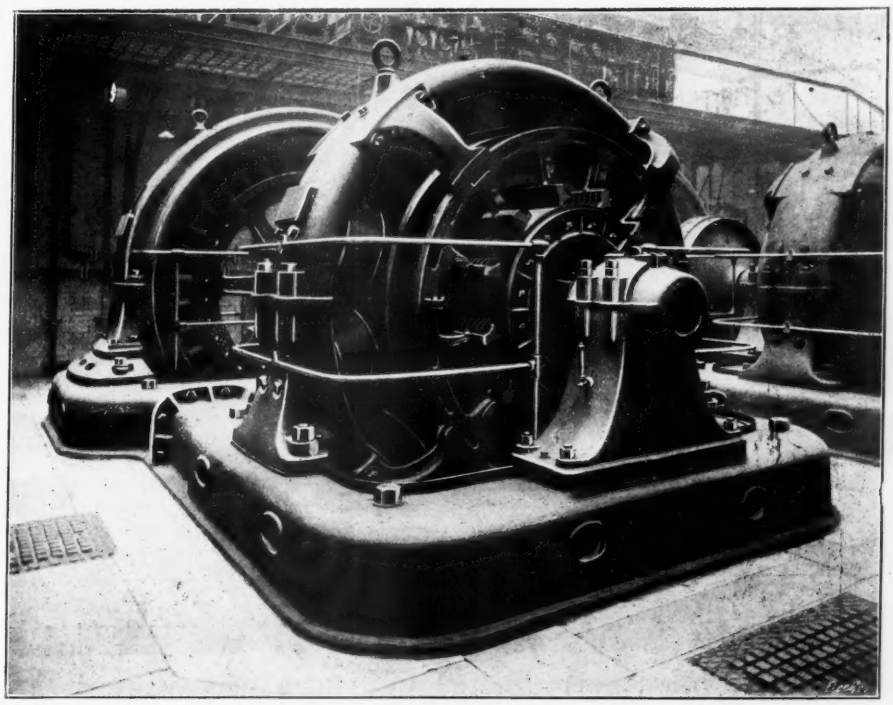
NOTE.—In our last issue we inadvertently described Amberley Road sub-station as being adjacent to Manchester Square generating station; for the latter read Amberley Road generating station.



NORTH STREET SUB-STATION: MAIN TRANSFORMER ROOM.

The next sub-station which we shall describe adjoins, and practically forms part of, the Manchester Square generating station of the Metropolitan Electric Supply Co. This sub-station commenced its existence as a transformer station in 1899, reducing the pressure of the Willesden supply from 10,000 to 1,000 volts, and working in parallel with the alternating plant at Manchester Square; the transformers were in all of 800 KW. capacity. The sub-station plant has been largely extended since that period, a new building having been erected in North Street, and plant installed for converting the two-phase supply to direct current, including in all transformers of 3,600 KW., and motor-generators of 3,225 KW., so that this is now one of the largest sub-stations in this country—perhaps the largest of all.

The transformer room illustrated herewith was put in operation in 1900, and contains transformers of 2,800 KW. capacity, in two banks corresponding with the two phases. These transformers, as well as those of 800 KW. in another room, are all of the Berry type, made by the British Electric Transformer Co., Ltd., and are of the standard size of 100 KW. each, as at Amberley Road. The whole of the switch-gear is also like that already described; the high pressure board is contained in the chamber which is seen to project into the room on the right hand, and on either side of it are the main switches in the high pressure circuits, by means of which the station can be isolated from the 10,000-volt mains. Arrangements are being made to install Thomson integrating wattmeters ...



NORTH STREET SUB-STATION: WITTING-EBORALL 500-KW. MOTOR-GENERATOR.

circuit with the latter, to record the whole of the energy supplied to the station. The meters will, of course, be connected in series with the outers of the cables (·5 sq. in. section, Harrow Road route) which are practically at earth potential, being dead earthed at Willesden; the pressure coils will be fed through transformers. Two-way switches are provided, by means of which the secondaries of groups of transformers can be coupled up with either the Manchester Square bus-bars, or the North Street sub-station bus-bars.

North Street: Asynchronous Motor-generators and Starting Apparatus.

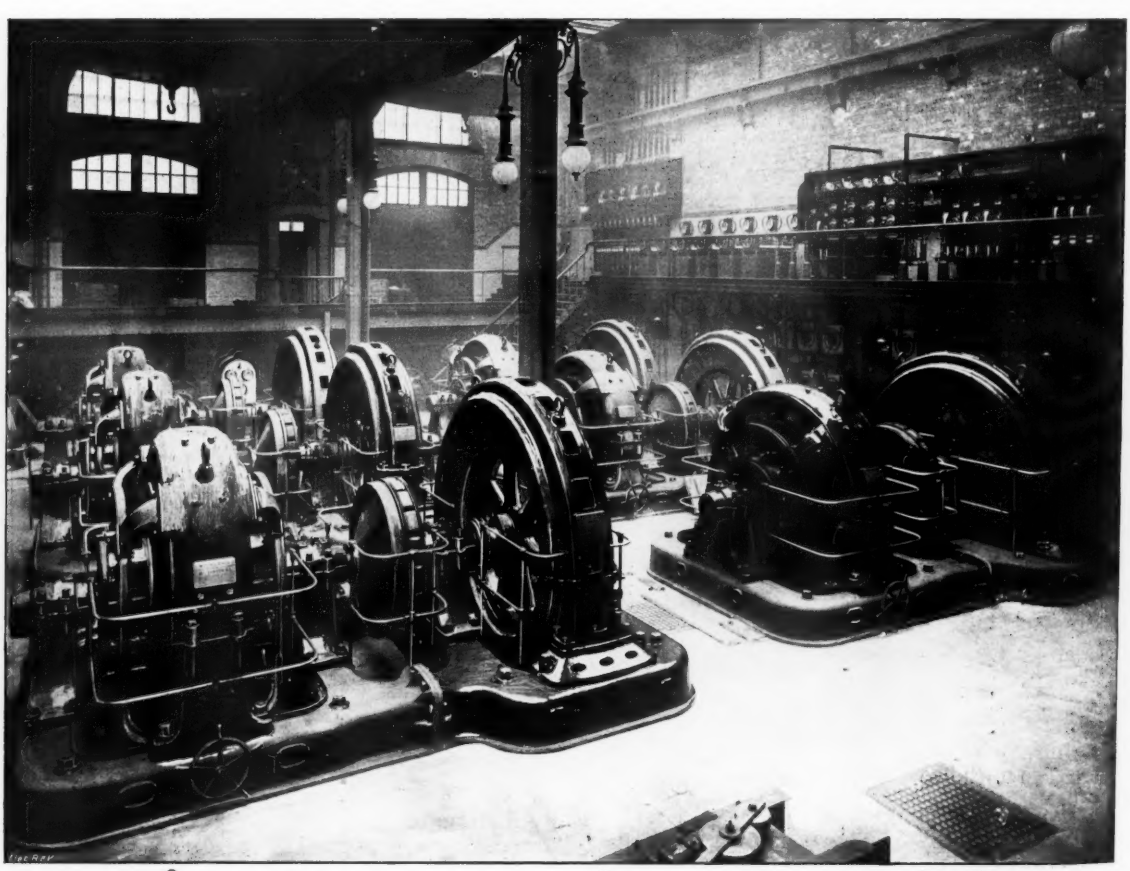
We may here remark that a great part of the extra-high pressure transformer switchgear was supplied by the India-Rubber, Gutta-Percha and Telegraph Works Co., Ltd., of Silvertown.

The motor-generators were all supplied by Messrs. Witting, Eborall & Co., Ltd., and include six sets of 500 KW. each, and three of 70 KW. each. The latter are driven by induction motors, and serve to start up the larger sets (which are driven by synchronous motors), but are also useful for taking the load in the small hours. These machines, with the corresponding switchgear, are housed in a single large room, well lighted from the roof, and served by two 15-ton electric three-motor cranes, one in each bay.

A landing stage at street level enables carts to be backed in under the cranes; beneath this, and over the three starters, runs a small hand traveller.

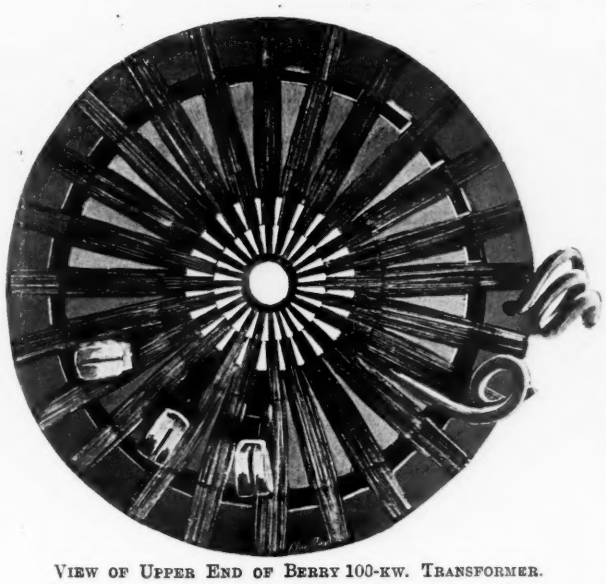
Arc lamps, carried on substantial cast-iron brackets, serve to light the building at night.

The motor-generators are rated at 500 KW. each, the motor being of the two-phase synchronous type, designed for 1,100 volts, 60 cycles per second, and the generator giving direct current at 200—230 volts. The motor has 34 poles, and therefore runs at 212 revolutions per minute; in this lies one of the great advantages of motor-generators compared with rotary converters, as the speed remains constant regardless of possible fluctuations of pressure in the alternating current circuits.



North Street Sub-station: General View of Motor-generators and Switchgear.

The machines are built on separate bed-plates, the generator shaft being driven through a "Zodel" flexible coupling (elevations and sections of the sets were given in our issue of April 12th, 1901); all the bearings are of the spherical-seated self-adjusting and self-oiling type. The armature core of the motor is of the usual laminated type, with six slots per pole per phase, and is carried in a cast-iron frame, with ample provision for ventilation. The field-magnet poles are of elliptical section, of solid cast-steel, bolted to a heavy spider; the heavy gun-metal cheeks of the bobbins act as damping circuits.



View of Upper End of Berry 100-kw. Transformer. Showing the Arrangement of the Core and the Provision for Ventilation.

The generator field-magnet frame is of steel, with 12 cast-steel poles bolted to it; the armature is double-ended, having two commutators working in parallel. The brush-holder rings are carried by cast-iron brackets projecting from the yoke, and are moved simultaneously by means of a single hand-wheel, provision being made for adjusting their relative positions during erection.

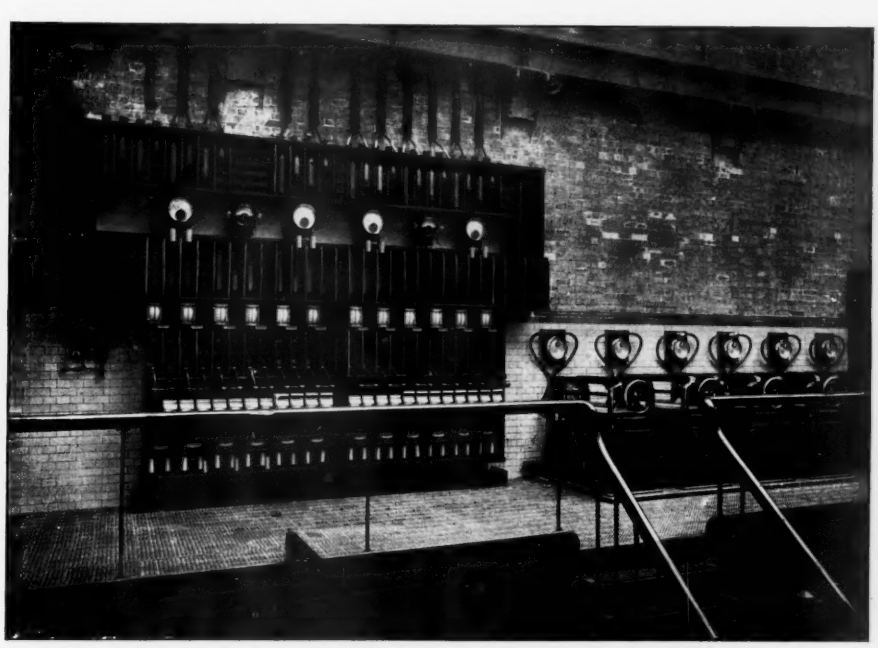
The connections between the switchboard and the motors are of concentric lead-covered cable, laid in cement troughs in the floor. The direct-current mains from the generators, on the other hand, are of bare copper strip, 3 in. wide × ⅛ in. thick, 15 layers of this being used for each conductor from the 500-kw. sets; these mains are carefully bent to suit the run of the cement troughs, in which they are supported on porcelain chairs, and the troughs are finally filled up solid with bitumen. The strips are bolted and sweated together wherever joints are required, and form a substantial job.

The 70-kw. starter sets consist each of a two-phase induction motor driving direct, through a flanged coupling, a 6-pole dynamo at 600 revolutions per minute. The starting apparatus for each starter set—for even starters must be started—is fixed close by, and is completely self-contained. One of our views shows two of these apparatus, with the machines in the background; the operation of starting is quite simple, the handwheel being slowly turned, while the motor starts and runs up to speed. The switchgear was supplied by Messrs. Witting, Eborall & Co., with Nalder ampere and voltmeters on the alternate current mains.

The main switchgear occupies the greater part of the end wall of the room, and is mounted on a gallery; the floor of the gallery consists of glass plates carried in an iron framework, supported from the wall by brackets. This construction, which we first met with in the Glasgow stations, has the advantages that it efficiently insulates the attendants from earth, and at the same time transmits light to the space beneath the gallery. On the left hand, as shown in our illustrations, is the Ferranti alternate current switchgear for the motor circuits; next comes the heavy starting gear for the direct current machines, and lastly, the Ferranti direct current generator switchboard.

The alternate current switchboard is of Messrs. Ferranti, Ltd.'s standard two-phase type for 1,000 volts, and provides for 12 concentric cables of ·4 sq. in. cross-section, six on each phase, from the transformer rooms and 12 cables leading to the synchronous motors. The board is practically in duplicate; there are two sets of bus-bars, one above the other, each in two parts coupled together by expanding screw plugs at the centre and rods at the ends. There are also two sets of synchronising gear and two pairs of voltmeters, so that the plant can be divided into two entirely independent portions, which may eventually be supplied from independent sources at Willesden, so as to render the possibility of a complete breakdown exceedingly remote.

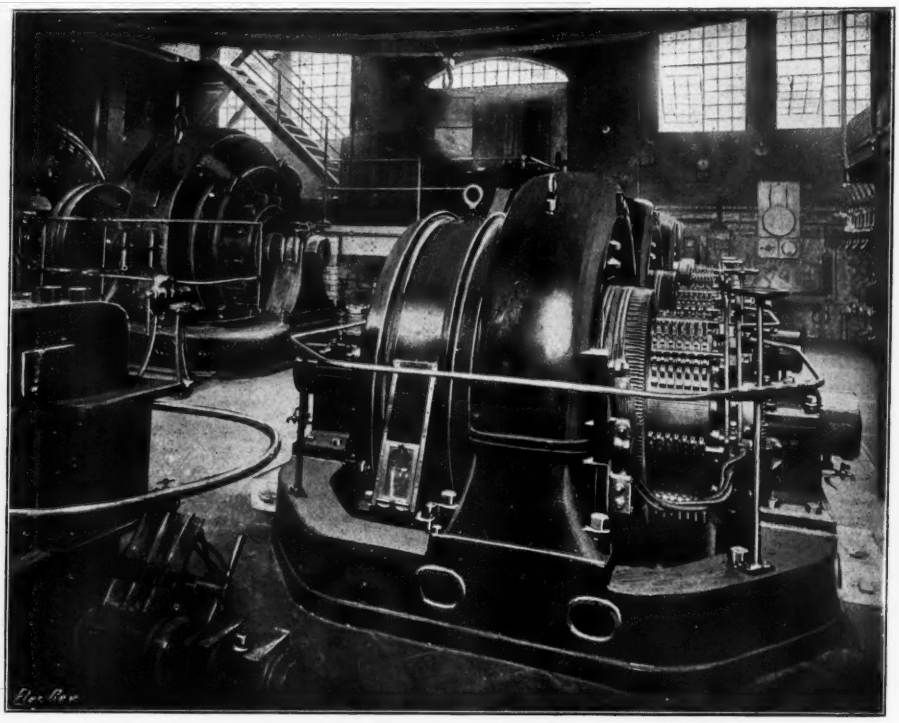
In accordance with the usual practice of the Supply Co., the transformer secondaries are earthed at their middle points; hence in this case double-pole switches are necessary throughout, one on each phase of each motor. An ammeter is inserted in each phase, as well as a Thomson integrating meter, which is provided also with an indicating attachment showing the kilowatts passing in each phase. The usual Ferranti oil-break switches and fuses are used. At present, 10 of the 12 cables from the transformers have been connected up. The outgoing cables to the motors are fixed against the wall below the gallery, and pass into ducts under the floor.



North Street Sub-station A.C. Switchboard and Starting Rheostats.

The six starting rheostats adjoining the A.C. switchboard are of very massive construction, the copper brushes—which in the extreme position are always in the main circuit—being very heavy, and in duplicate. The brushes travel

over horizontal guides and rows of contacts connected with metallic resistances in ventilated metal casings, their motion being derived from a multiple-threaded screw rotated by means of a hand-wheel. An ammeter in circuit with each



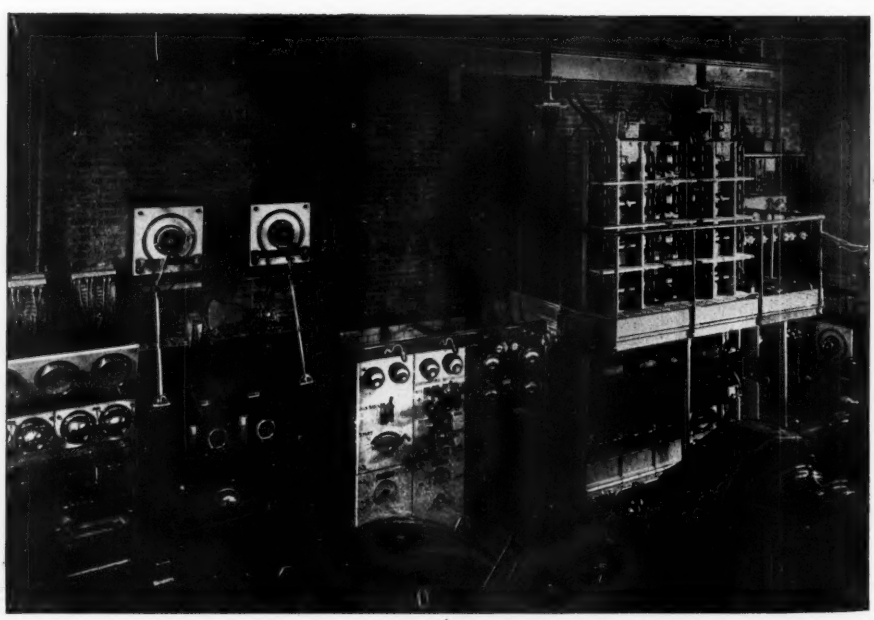
Tower Street Sub-station: General View.

rheostat enables the operator to regulate the speed of starting to a suitable value. From these rheostats heavy copper connections beneath the gallery run to the generator switchboard, which, like the A.C. board, is in two parts which can be independently worked.

Over the top of this board are two sets of horizontal bus-bars, of which the upper set are connected with the starters, and the lower are the main bus-bars. The large motor-generators are always started on the direct-current side. Two-way switches working between the above-mentioned bus-bars enable any machine to be coupled first to the starter bus-bars for starting; afterwards, when full speed has been attained, and the motor has been paralleled with the A.C. supply, the switches are thrown down, and the generator is paralleled with the main bus-bars in the usual way. On one pole of the generator is an ammeter, and by the side of this, on the other pole, is an automatic switch. The latter consists of massive jaws, into which a heavy laminated copper bridge is forced, the jaws being flat surfaces at an angle of 90° with each other; a hand-wheel and screw performs the operation of closing the switch, but it can be instantaneously opened by means of a trigger, either automatically or by hand. In either case the hand-wheel has to be turned backwards to the full extent, thus ensuring a reasonable pause before closing the switch again, during which a possible short-circuit may have gone off the mains. Switches for breaking the fields of the motor and generator are fixed below; the rheostats for regulating the excitation of the machines are fixed under the gallery, and are actuated by means of bevel gear by hand-wheels mounted in front of the respective panels. These regulators are better seen in our view of the Tower Street sub-station, below.

A small board for controlling the D.C. sides of the starter motor-generators is fixed near the main board, with regulating rheostat and two-way switches for coupling to the upper or lower bus-bars, exactly as on the main board. Automatic switches, ammeters and oil-break fuses are provided on this board.

Portable voltmeters of the N.C.S. type are used for paralleling the D.C. generators. The whole of the switchgear described above is of unusually substantial construction, and presents a very handsome appearance. It will be noticed that for both direct and alternating currents, the Ferranti cellular type of board has been

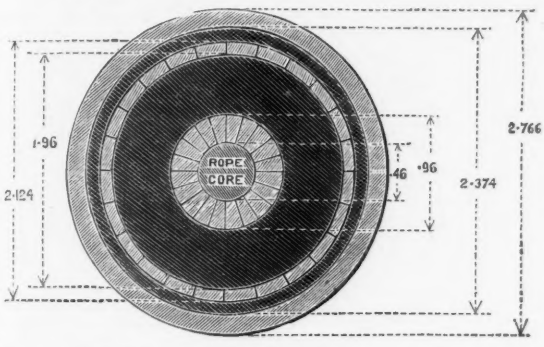


Tower Street Sub-station: Switchgear.

adopted, which occupies, we should think, the irreducible minimum of space, and is at the same time safe to the operator and very accessible.

The connecting mains between each end of the generator

switchboard and the distributing board are of bare copper strip, 20 × 3 in. × $\frac{5}{32}$ in., similar to the leads from the generators to the switchboard, taped over to prevent accidental contact, and are carried down the wall behind the switchboard in porcelain chairs to the distributing board, which is situated in a long room in the basement. The distributing board is of imposing length, being designed for 100 feeders, in addition to the generator connections. Three copper bus-bars—positive, negative and neutral—of large cross-section, run from end to end of the board, but can be divided in the middle by means of massive coupling blocks. The generator mains are connected direct to the positive and negative bars, but are provided with multiple links at the upper end,



Section of 10,000-volt B.I.W. Feeder Cable, ·5 sq. in. Cross-Section.

by means of which they can be disconnected from the generator bus-bars at will. The distributor bars are also connected in the same way with the direct-current bus-bars in the Manchester Square station by conductors 15 × 3 in. × $\frac{5}{32}$ in., the whole of the direct-current plant being run in parallel. By means of the links above mentioned, either half of the distributing board can be laid idle in case of need.

The feeders are all of the British Insulated and Helsby Cable Co.'s triple-concentric lead-covered type, of ·4 sq. in. cross-section, and are joined to the positive and negative bus-bars by fuse switches. In circuit with each pole of each feeder is an ammeter shunt, by means of which the current flowing in each conductor can be measured, if desired. One ammeter is provided for 10 or 12 feeders, with flexible leads to reach the various shunts. The neutral conductors are joined direct to the corresponding bus-bar. The feeder cables pass downwards into Doulton conduits under the floor, and are led to a cable race at the end of the room, up which they run and through ducts to a very large manhole in North Street; thence they are led away to the respective districts supplied.

As the supply pressure is 100 volts on either side of the three-wire system, it will readily be understood that there is an enormous amount of copper in the direct current connections in the station and in the feeders; all the switchgear is very massive, and the section of the conductors has been calculated on liberal lines. The distributing board above described was made by Messrs. A. Reyrolle & Co., Ltd., of Hebburn-on-Tyne.

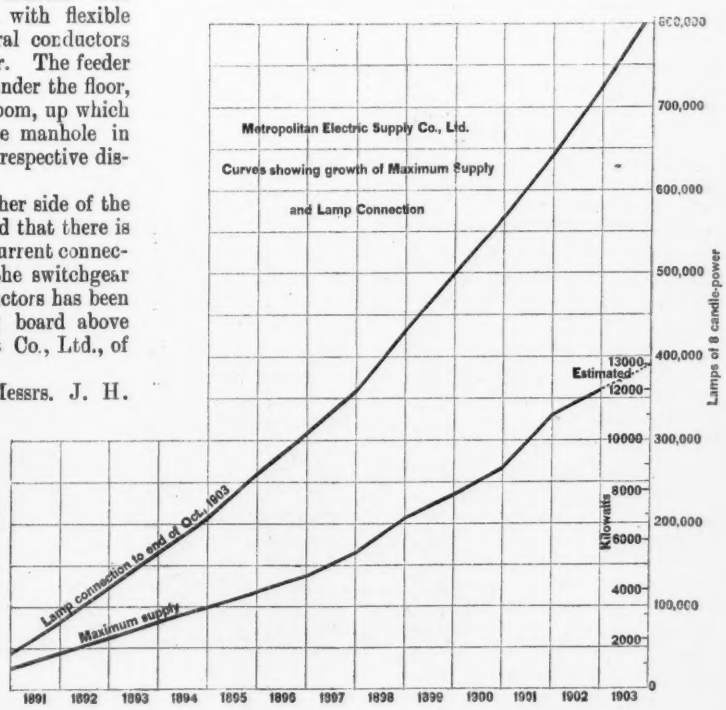
Two balancers are provided, made by Messrs. J. H. Holmes & Co., of Newcastle-on-Tyne; these are of the 2-pole inverted type with drum armature, and are rated at 275 amperes at 100 volts, 700 revolutions per minute. The small amount of balancing plant found necessary is a noticeable feature of this and the Tower Street sub-station. The switchgear in connection with the balancers is mounted on a small board standing in front of the main generator board on the gallery.

A large part of the plant has been completed and tested, and on Tuesday last, for the first time, the supply of direct current was commenced from this sub-station. In the adjoining Manchester Square station, the alternators of the Parsons turbo-generators are being replaced by direct-current generators, which will shortly be put to work in parallel with the motor-generators. We may remark that, as our readers are aware, the work of the Supply Company has been seriously hampered during the past year or two by the negotiations with the Metropolitan Borough Council of St. Marylebone, it being impossible to make rapid progress while their issue hung in the balance. Now that an agreement has been arrived at, as reported recently in our columns, the necessary alterations and extensions essential to the efficient conduct of the business are being pushed forward. In passing, we may draw attention to the fact that, though the alternators are being replaced by dynamos, the original steam turbines are being retained in use.

This would seem to be strong evidence of the durability and satisfactory working of the Parsons turbine.

The third sub-station which we describe is situated in Tower Street, near Seven Dials, and is a motor-generator sub-station from which only direct current is distributed, though alternating current is transmitted thence to Sardinia Street station at times. Unfortunately, the sub-station is by no means a favourable subject for photography, and it is, therefore, difficult to convey an adequate idea of its contents and arrangement by this means.

The transformers are, as before, of the Berry type, and are installed in the storey over the motor-generator room; they are 16 in number, of 100 kw. each, and are arranged in groups of 3, 2 and 3 on each of the two phases. The arrangement of the switchgear and of the high-pressure compartment is similar to that at the sub-stations already described. In passing, we may note that Berry transformers of more than 21,000-kw. capacity have been supplied to the company by the British Electric Transformer Manufacturing Co., Ltd. All these transformers are of the same form—annular horizontal primary and secondary coils, interspersed with one another, and interlinked with a number of radially-disposed laminated iron systems, leaving abundant surface for cooling by radiation and convection. The manner in which the iron is arranged inside the coils, so as to provide air-ducts between the several bundles of laminations, is well shown in the figure on p. 825, while the mode of building up and insulating the windings (the bottom coil of the 10,000-volt primary being at earth potential, and there being a large clearance between the iron cores and the coils at the top) enables a large factor of safety against breakdown to be secured. We believe we are right in saying that the Supply Co. has never called upon the



makers to repair any Berry transformer on account of breakdown due to faulty construction.

The 1,000-volt secondary cables from the transformer room pass down through the floor, some going to a fuseboard on an elevated platform below, where they are led through Bates

fuses to bus-bars, and from these, again through fuses, to the E.C.C. motor board below, while the majority go to a Ferranti board, as at North Street. The latter is, as before, divisible into two sections, each supplying one 500-KW. motor-generator, and is provided with a ring of four bus-bars. There are eight panels, holding two double-pole switches for each set, and the ammeters, energy meters, and synchronising gear are all duplicated as at North Street. The motor field regulators, with 64 points each, are fixed at either side of the board. Close by the latter there are two Cowan regulating transformers in circuit with A.C. feeders running to Sardinia Street station; each of these is rated to carry 150 amperes, giving a variation of 120 volts in all. At the time of our visit 140 KW. was being supplied through one of these.

The Ferranti motor-board is connected with two 500-KW. motor-generators of exactly the same pattern as those installed at North Street, and supplied also by Messrs. Witting, Eborall & Co., Ltd.

The E.C.C. motor-board is connected with four motor-generators supplied by the Electric Construction Co., Ltd., of Wolverhampton, and consists of four panels, each equipped with two voltmeters and two ammeters, and one double-pole double-break two-phase 1,000-volt switch, with automatic overload release. This switch is used to start the motors, which are of the asynchronous type; the main switch is thrown in first, and the machine runs up nearly to full speed, after which a switch on the motor frame is closed, short-circuiting the rotor winding. The machines can also be started from the direct-current mains if desired.

The induction motors are built very close to the generators, there being only two bearings. The generators are of the six-pole form, with drum armatures, and have an output of 140 KW. each.

The direct-current switchboards are onthe left-hand, the first being made by the E.C.C., and the second by Messrs. Ferranti, Ltd. The former controls the 140-KW. generators, and comprises four panels, each carrying volt and ampere-meters, a double-pole switch with automatic minimum release, D.C. starting rheostat and regulating rheostat. Over the board there are six feeder pilot voltmeters.

Next to this board is fixed the board controlling the 500-KW. sets, which is identical in pattern with the D.C. board at North Street. In this case the starting bus-bars on the top of the board are connected with one of the E.C.C. generators, which is regularly used as a starter for the large sets. The regulating rheostats for the generator fields can be seen in the illustration, fixed on the wall above the board.

A motor-driven booster rated at 800 amperes and up to 40 volts, supplied by Messrs. Witting, Eborall & Co., is fixed in the sub-station, and is controlled by the switchgear, which, by virtue of its marble panels, appears prominently in the view on p. 826. This set is used for boosting the pressure on one or other of two D.C. feeders running to Whitehall Court and Sardinia Street respectively. A balancer made by Messrs. J. H. Holmes & Co., of 275 amperes capacity at 100 volts, 700 r.p.m., is also installed, with the corresponding switchgear.

The motor-generator room is traversed by a 14-ton electric crane, made by Messrs. Higginbotham & Mannock, and driven by a motor supplied by Messrs. Witting, Eborall & Co.

It is intended to install at this station a battery capable of giving 400 amperes for three hours, made by the Accumulator Industries, Ltd., of Woking. In connection with this, a booster-balancer is being put down, consisting of four machines coupled together. These were supplied by the Electric Construction Co., Ltd., and comprise two balancers rated at 110 amperes, 115 volts each, and two boosters, rated at 1,000 amperes, 25 volts each, the whole set running at 600 revolutions per minute. The switchgear, supplied by Messrs. A. Reyrolle & Co., Ltd., consists of two panels, bearing six heavy knife switches, two main fuses, regulating gear and instruments.

Athough very far from exhaustive, the foregoing descriptions will serve to show that the Metropolitan Electric Supply Co., Ltd., which bore the heat and burden of the day in pioneer times, has by no means come to a standstill. It is, in fact, rapidly extending its operations, and by the adoption of direct current supply it will undoubtedly benefit largely by an important motor load.

The rate of increase in the number of lamps connected is actually increasing, as will be gathered from an examination of the diagram given on p. 827, for which we are indebted to Mr. J. S. Highfield, chief engineer to the company.

The company has introduced a scheme of motor hiring and hire-purchase, which has already begun to bear fruit, and the charges for power have been revised and reduced; the schedule is now based on the maximum demand system, the charges being 3d. per unit for an average of two hours' daily use of the maximum demand in each quarter, and 1½d. per unit for all energy in excess. Further, the use of radiators and cooking apparatus is being encouraged, and a scheme for the hire and hire-purchase of installations, including fittings and lamps, has been formulated. The charge for lighting is 6d. per unit, with a scale of discounts depending jointly upon the magnitude of the load and on the load factor; the average price per unit obtained last year was 4·85d. Additional plant is on order to meet next year's demand, including eight 500-KW. motor-generators, to be made by Messrs. Dick, Kerr & Co., Ltd.

In conclusion, we wish to express our appreciation of the courtesy and kind assistance afforded us in the preparation of this article by Mr. Highfield, by the respective station superintendents, and by some of the contractors.

FORTHCOMING EVENTS.

Friday, November 20th.—At 8 p.m. Junior Institution of Engineers. Paper on "Fires on Shipboard; their Chief Causes, and the Method for Prevention and Extinction," by Mr. G Canning.

Saturday, November 21st.—At 2.30 p.m. Junior Institution of Engineers. Visit to Orchard Dock, Blackwall, to witness a demonstration of fire extinguishing, &c.

Monday, November 23rd.—At 7.30 p.m. Institute of Marine Engineers. Meeting at the London Institution. Presidential address, and presentation of the Denny medal to Mr. C. W. Barnes.

At 8 p.m. Society of Arts. Cantor lecture. "The Mining of Non-Metallic Minerals," by Mr. B. H. Brough. Lecture I.

Wednesday, November 25th.—At 8 p.m. Society of Arts. Cantor lecture. "The Universal Exposition at St. Louis, U.S.A., 1904," by G. F. Parker.

At 2.30 p.m. Institution of Civil Engineers. Students' visit to the Great Northern Railway; underground stations at Finsbury Park.

Thursday, November 26th.—At 8 p.m. Institution of Electrical Engineers. Meeting at Institution of Civil Engineers. Papers by R. Threlfall, F.R.S., on "The Testing of Electric Generators by Air Calorimetry," and Mr. W. Hibbert on "The Edison Accumulator for Automobiles."

The Glasgow University Engineering College. Paper by Mr. P. D. Ionides on "Design of Modern Electric Power Stations."

Friday, November 27th.—At 5 p.m. Physical Society. Meeting.

Saturday, November 28th.—At 7.30 p.m. Glasgow Technical College Scientific Society. Mr. J. H. Pocock on "Some Remarks on the Willans Engine."

NOTES.

Electro-Harmonic Society. — The first "Ladies' Night" of the season was held in the King's Hall, Holborn Restaurant, under the presidency of Mr. Robert Kaye Gray, on Friday last, 13th inst., and very excellent musical fare indeed was provided. Without attempting to deal in any detail with the many good things in the programme, we may remark that it would have been difficult to find better vocalists for this kind of concert than the trio who appeared on Friday, namely, Miss Gertrude Maxted, Miss Lilian Gardner, and Mr. Harry Dearth, whose songs were one and all thoroughly enjoyable and artistic. The string orchestra was, as usual, all that could be desired, especially in Nicolai's charming overture, "The Merry Wives of Windsor." Mr. T. E. Gatehouse and Mr. A. E. Izard contributed violin and pianoforte solos, and the humorous element was most amusingly introduced by Messrs. Corner and Henry (duets) and Mr. Barclay Gammon (sketches). Taken all round, it was easily the best Ladies' Concert of recent years, and the musical directors of the Society will have to make no small efforts to keep up to this standard in future. However, we do not despair of their being equal to the task, as the

Society's concerts, with, perhaps, an occasional lapse, have been steadily improving of late years, a sign of the times which the members are not slow to appreciate, judging from the large and representative gathering which completely filled the King's Hall on Friday evening, and also from the considerable number of new members who are joining the Society this season. The elections, indeed, have already been so numerous that the committee have just made the welcome decision to hold the Smoking Concerts on December 18th, and March 25th in the King's Hall instead of in the Crown Room, and they hope that this popular step will be justified by further increase in membership during the rest of the season.

Royal Commission on London Locomotion.—A further sitting of this Commission was held under the chairmanship of Sir D. Barbour on Thursday last week, when evidence was given by Mr. A. Young, the valuer to the London County Council.

Sir Alexander Bruce, the Assistant Commissioner of Police, then gave evidence with reference to the regulation of traffic.

Premium Pupils in Electricity Works: Prof. Thompson's View.—Prof. S. P. Thompson, writing from the Finsbury Technical College to last week's *Engineering* on "The Appreciation of Technical Education," says:—

"There has just been put into my hands a striking example of the way in which technical education is discouraged by the very bodies who are charged by Government with its promotion. The Urban District Council of Erith wants an assistant in its electric lighting works, on which £43,000 has already been spent. One of the Council's officials sends a letter to us at the City and Guilds of London Institute, informing us of this vacancy, and briefly describing the features of the undertaking. It winds up, not by saying that the post will be given to the youth who has shown that he is most efficient, well-equipped in a knowledge of electrical work, competent in electric testing, a capable draughtsman, or a clear-headed calculator. No, it announces that the post will be open to a youth who pays a premium of £50 per annum. Who is to get the premium? The Urban District Council? To those who had supposed that the district and county councils took some interest in education, and had some pride in the scholars trained in the technical institutes and colleges, it is a rude shock to find an urban district council thus riveting on its own electrical undertaking the worst enemy of technical education—the premium-pupil system, which has been the curse of British engineering."

Lord Kelvin on Engineering Training.—On 13th inst. Lord Kelvin received the honorary degree of D.Sc. from the University of Wales. He also, on the occasion of his visit, received the honorary membership of the South Wales Engineers' Institute, and in the course of an interesting speech in acknowledging the honour said, according to the report in the *Times*, he had always had the deepest sympathy with engineering on the one side and University training on the other, because engineering was giving, perhaps, the most interesting application of the science learned in the University for the benefit of mankind. He remembered with pride that the first chair of engineering in any university in the country was that founded in Glasgow. He felt that engineers all over the world had still a good deal to learn as to the real value of University training, but he did not think that in South Wales they needed reminding of that fact. Proceeding, Lord Kelvin contrasted the old system of apprenticeship of the engineer with the more modern ideas. He did not desire to make comparisons, but in the matter of the education of foremen in engineering works, the Germans had learned how to give them scientific knowledge in a way in which we in England had not given it. It was necessary for the young engineer to learn the practical as well as the theoretical, and this could only be accomplished satisfactorily by the student spending half his year at the University and half in the workshop, where he might learn to apply the scientific knowledge which he had acquired in the University. He would suggest this to the University College of South Wales and to the members of the Engineers' Institute, and would ask employers to endeavour to make some arrangement whereby their engineering pupils might be able to do this.

Obituary.—James Hookey.—Still another link in the chain, which connects the early days of the electric telegraph with the present time, has been broken by the death of Mr. James Hookey, late Engineer-in-Chief to the Post Office. It was but in the early part of 1902 that, pressed by his medical advisers, Mr. Hookey was persuaded to retire from the position in the Postal Telegraph Service, which for about three years he had so well filled. Always an active man, it seems to have been impossible for him on his retirement to take that amount of rest which he so much needed. So keen was his enthusiasm in everything to which he lent a hand that, regardless of his personal welfare, he continued to assist in various philanthropic works in which he had always taken so great an interest. He was taken ill whilst on one of these missions, and, after lingering for some days, passed away on Saturday morning, the 14th inst.

Born in Bristol in 1839, and educated at Bath, Mr. Hookey, at the age of 16, entered the service of the Electric Telegraph Co. Here his engineering and administrative ability soon advanced him to a position of trust, and in 1862 he was promoted to a still higher position in London, where, after declining an important position with a railway company, he elected, on the transfer of the telegraphs to the State, to join the Post Office Service.

His intimate knowledge of the details of the telegraph system soon marked him out for advancement, and, after serving under three successive engineers-in-chief he was, in 1899, appointed to the position vacated by Sir William Preece.

As head of a department which was then, and is still, making rapid strides, both commercially and scientifically, Mr. Hookey occupied a most responsible position, and his thorough knowledge of the inner workings of his department enabled him to carry on the administration very successfully. His grasp of detail was very remarkable, and being possessed of a retentive memory, probably no man connected with the service was so thoroughly familiar with all the ramifications of the immense wire and line mileage of the whole telegraph system as he was; he knew all by heart, and, it is said, could quote chapter and verse for almost any wayleave or easement connected with them throughout the country. He made his profession his hobby, and often late at night he might be found in his office hard at work; indeed, had he taken life less seriously, there is little doubt that his career would not have terminated for several years to come.

His experience of railway working proved of immense service to the State during the transfer of the telegraph lines, while his dealings with the various companies, whether on the subject of maintenance or manufacture, always exhibited tactfulness and resource.

Many improvements and modifications were carried out in the telegraphic and telephonic apparatus during his term of office, and although he could scarcely be described as a technical expert, he was perfectly familiar with every branch of electrical engineering, and would readily grasp the salient points of any suggestion brought before him.

Always sympathetic and encouraging, Mr. Hookey will be greatly missed by those who were brought within his circle of friends; he was ever ready to assist by his experience and advice, and many a charity will be the poorer by his decease. As an instance of the high respect in which he was held by the officers of his staff, it may be mentioned that nearly 1,000 names appear in an album accompanying a testimonial which was presented to him upon his retirement.

Colonel Pescetto.—Many engineers in this country will be deeply grieved to learn of the death of Colonel F. Pescetto, the well known Italian electrical engineer, who passed away on 12th inst., at the early age of 56. Colonel Pescetto made several visits to England, and established cordial friendships, which were renewed on the occasion of the visit of the Institution of Electrical Engineers to Italy this year. We respectfully tender our sincere sympathy to his bereaved family and colleagues.

Institution of Electrical Engineers.—The following are the papers down to be read in London during the current year:—

November 26th.—"The Testing of Electric Generators by Air Calorimetry," by R. Threlfall, F.R.S. "The Edison Accumulators for Automobiles," by W. Hibbert.

December 10th.—"The Ondograph," by E. Hospitalier. "On the Magnetic Dispersion in Induction Motors and its Influence on the Design of these Machines," by Dr. Hans Behn-Eschenburg.

December 17th.—"The City and South London Railway: Working Results of the Three-wire System Applied to Traction, &c.," by P. V. McMahon.

Drying Peat Electrically.—A correspondent who has devoted considerable attention to this subject, and has made experiments respecting electrical peat drying, informs us that in the course of his experience he has found in the first place, as soon as the peat arrives at boiling temperature, the resistance increases so enormously that it is practically impossible to get any current through it, and raising the voltage only has the effect of separating the electrodes from the body of the peat. In the second place, if the process is stopped as soon as the peat reaches boiling temperature, it is found that it has undergone some change which permits of its being treated by other processes, the nature of which he is not quite sure of, but the effect of which is claimed to produce briquettes in a few hours only, so hard and firm that they can be polished like ebonite. In this, however, our correspondent is dependent upon other people's word, as he has never seen the briquettes actually made. In the third place, the cost of raising the raw peat to boiling point is so great that a company working the process could hardly produce enough fuel to feed its own boilers. Fourthly, there is produced as a by-product of the electric process a certain amount of oil, having the characteristics of petroleum, which might be of some value.

Royal Society Medals.—The Royal Society has this year awarded the Davy medal to M. Pierre Curie and Madame Curie for their researches on Radium; and the Hughes medal to Prof. Wilhelm Hittorf for his long-continued experimental researches on the Electric Discharge in Liquids and Gases.

Jandus Arc Lamp and Electric Co., Ltd., v. Arc Lamp Co.—This case came before Mr. Justice Kekewich in the Chancery Division on Wednesday.

Mr. Wm. Graham said the action was brought by the plaintiffs to restrain the infringement of two patents by the defendants. The plaintiffs for whom he appeared had been advised that neither of their patents in the form in which they now were could be safely litigated upon, and the motion was for plaintiffs to be allowed to amend their specification and the pleadings.

Mr. Bousfield, K.C., on behalf of the defendants, submitted that as the plaintiffs could not win on their present materials, the action ought to be dismissed.

In the result his Lordship granted the application in the form of the order made in the well-known Ruddington case. It was also directed that the action should stand over formally.

Engineering Standards Reports.—The Engineering Standards Committee have appointed Messrs. Crosby Lockwood and Son, of 7, Stationers' Hall Court, E.C., as official publishers to the Committee. All the reports and specifications published by the Committee may be had from the official publishers to the Committee, or direct from the offices of the Committee, 28, Victoria Street, Westminster.

Who are H. W. Bramley & Co., Electrical Engineers?—H. W. Bramley described on the plaint note as an electrical engineer, of 75, Thorold Road, Ilford, was sued at Lambeth County Court on Wednesday by the Imperial Motor Co., Brixton, to recover £4 15s. 6d., repairs to a bicycle. Defendant pleaded infancy. In reply to Judge Emden, he stated he considered it an honourable plea, and he would not withdraw it.

Judge Emden: I gave you an opportunity of getting honourably out of it, and you did not take advantage of the opportunity. I now hold that your plea is bad in law, as the contract was for your benefit.

The solicitor for the plaintiff company said the young man had received the cost of the repairs from an insurance company.

Judge Emden (to defendant): What is your age?—17.

Well, you are a promising youth. What did you do with the money you got for the insurance on your bicycle?—I spent it.

On judgment being entered for the plaintiff company with costs, the solicitor for the company stated that defendant was well able to pay at once. He handed up an imposing billhead showing that Bramley traded under the title of H. W. Bramley & Co., electrical engineers.

Judge Emden (to defendant): Who are H. W. Bramley & Co.?—I am H. W. Bramley and the company.

Do you tell the persons you have business with that you are an infant?—No, but they know when they see me.

I should say, young man, that you take very good care that they do not see you, or, if they do, you don't admit you are H. W. Bramley & Co. The law permits you to assume the title, but it is a gross piece of impertinence.

Defendant: Is there any reason, your Honour, why I should not carry on the business?

Judge Emden: Nothing I could say would appeal to your standard of morality.

The Court Registrar: A short order, your Honour?

Judge Emden: Certainly; the "company" must pay at once.

Institution of Electrical Engineers (Glasgow Section).—Mr. W. A. Chamen, president of the Glasgow Local Section of the Institution of Electrical Engineers, delivered the inaugural address at the opening meeting of the section, taking for his subject "The Electrical Developments of the Future." Surveying the present position of the electrical industry, he devoted much attention to the steam turbine and the gas engine as devices which were likely to supersede the steam engine in connection with the generation of electricity.

South African Trade.—The *Board of Trade Journal* announces that correspondents responsible for supplying special commercial information have now been appointed at Cape Town, Port Elizabeth, Johannesburg and Bloemfontein.

London School Board.—At the last weekly meeting the Works Committee reported that the managers had called attention to the insufficiency of the lighting at the Gravel Lane School, Houndsditch, and had asked that it might be improved either by the provision of electric light or incandescent burners. The assistant architect reported that a large number of burners injuriously affects the atmosphere of the rooms, and the Committee had therefore come to the conclusion that it would be desirable to provide electric lighting for that purpose. They accordingly recommended that an estimate of £398 for the installation be approved, and that the work be carried out by the Board itself. The charge of the City of London Electric Lighting Co. for the supply of current was 3d. per B. of T. unit, this being the lowest charge hitherto made. The recommendation was agreed to.

Personal.—We understand that Mr. Frank B. Cramer has left the International Electrical Engineering Co., where he held the position of technical manager, and has re-joined Messrs. Johnson & Phillips, with whom he was formerly associated for some years.

The *Times* announces that at a meeting of the electors to the Professorship of Mechanism and Applied Mechanics, held at Cambridge on 14th inst., Mr. Bertram Hopkinson, M.A., of Trinity College, was elected in the place of Mr. J. A. Ewing, resigned.

Mr. Jackson has been appointed electrical engineer at Pontefract Workhouse by the Board of Guardians.

The City address of Mr. E. Kilburn Scott, M.I.E.E., A.M.I.C.E., is 13, St. Helen's Place, where he is associated with Messrs. Harper Bros. & Co. in the engineering work of the North Wales Power and Traction Co., the Bath and Sunderland District Electric Tramways, &c.

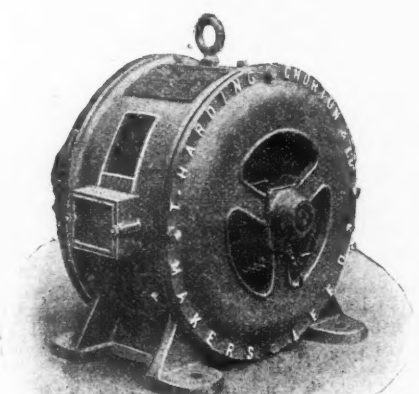
Mr. Alexander Moir, who has been stationed at Newcastle for the past seven years as assistant superintending engineer of the postal telegraph service, has been appointed to a technical officership of the first class upon the engineer-in-chief's staff at the General Post Office, London. Mr. Moir is at the present time vice-chairman of the Newcastle Section of the Institution of Electrical Engineers.

Mr. J. B. Gibbons, engineer, City District National Telephone Co., has been appointed engineer to the Oriental Telephone and Electric Co., and wil lshortly proceed to the East, for the purpose of conferring with the local managers and advising the Board as to what system of underground cabling should be adopted for their exchanges in India, China, Burmah and the Straits Settlements.

Institution of Electrical Engineers (Birmingham).—The opening meeting of this section, which had been postponed, has now been fixed for December 2nd, when Mr. J. C. Vaudry will deliver his address.

Electric Lighting Loans.—On Wednesday the St. Pancras B.C. considered a letter from the comptroller of the L.C.C., intimating that a required loan of £23,960 for electricity purposes, repayable in 42 years, could only be advanced to the Borough Council at £3 15s. per cent. per annum, instead of £3 10s., the rate of interest which previously obtained in the case of local loans. The comptroller added that the Finance Committee of the County Council desired to take the opportunity of emphasising the desirability, in view of existing financial conditions, of the borrowings of local authorities being restricted, as far as possible, to schemes of an urgent character. Inasmuch as the Prudential Assurance Co. offered to advance St. Pancras the needed loan at £3 12s. 6d. per cent. per annum, the Borough Council decided to seek the sanction of the County Council for the acceptance of this offer.

The "Atlas" Motors.—Some new types of motors for continuous current and polyphase circuits have been placed upon the market by Messrs. T. Harding Churton & Co., of Atlas Works, Ingram Street, Leeds. The illustration shows the polyphase induction motor, which is supplied for either two or three phases. The rotors are either of the "short-circuit" type (P.C. type, as shown), in which the conductors consist of copper bars, connected at the ends by short-circuiting rings, or of the slip-ring type (P.S. type), which are wire-wound and provided with slip-rings to enable an external resistance to be inserted in the rotor circuits when starting up or for controlling the speed. To start motors with short-circuited rotors, except for the smallest sizes, which can be switched directly on to the mains, Messrs. Churton supply a starting transformer-switch (or auto-starter) for the stator, or primary, circuits. For motors with wound rotors and slip-rings, multiple-contact switches and resistances are supplied, with which the motors can be started against full load with about full load current, and up to twice the

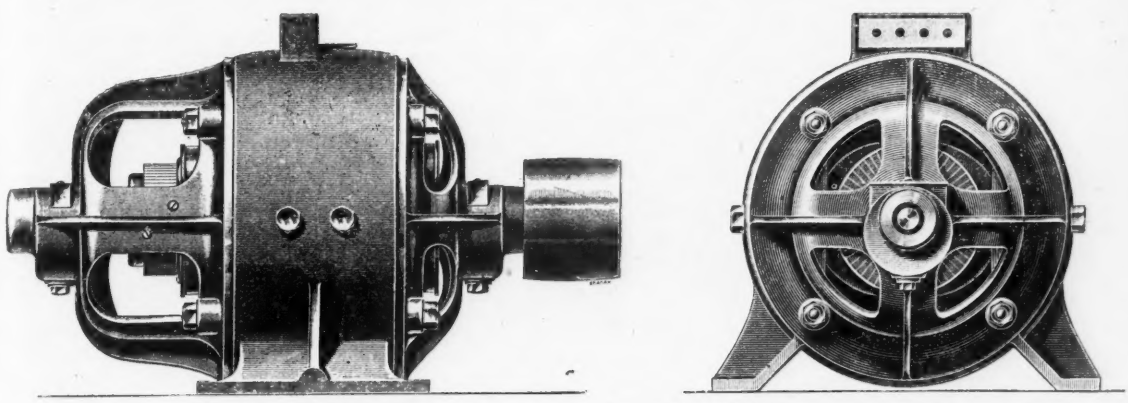


Polyphase Motor.

full-load torque, the current is nearly proportional to the torque. The speeds given in the list are based upon a frequency of 50 periods per second, but the motors can be wound for other frequencies and speeds. The efficiency of the motors is claimed to be extremely high, because of the special form of construction, which, though involving a slight addition to first cost, soon repays the extra outlay in the reduced cost of working. At the same time a very high power factor is obtained, which is of importance to the suppliers of the current. The temperature rise on normal full-load running is said to be very moderate, and to admit of the motors running on heavy overloads without injury. An illustrated list of these motors, giving prices and other particulars, has been issued. A second circular deals in a similar manner with the continuous current type. Copies of either can be obtained on application to the firm.

Electric Installation for an Indian Jute Mill.—A large order has recently been given to the British Westinghouse Co. for two turbo-generators and auxiliary plant for driving the large jute mill of Messrs. Birkmyre Bros., on the River Hugli, near Calcutta. The turbo-generators will each be of 1,300 KW. capacity, furnishing three-phase current at 440 volts and 25 periods. Each turbine will exhaust into a vertical surface condenser having 4,800 sq. ft. of cooling surface, and the exciter generators, of 20-KW. each, will be mounted direct on extensions of the turbine shaft. The turbines are to be of the multiple-expansion parallel-flow type, running at 1,500 revolutions per minute. With steam at 1,175 lbs. per sq. in., 27½ in. vacuum, and 200° F. superheat, a low steam consumption will be attained. There will be eight boilers of Messrs. Davey, Paxman's "Economic" type. The various departments of the mill will be driven throughout by Westinghouse polyphase induction motors, type C, of sizes varying up to 700 H.P. The 700-H.P. motors, three in all, will run at 290 revolutions per minute, and will be direct coupled by solid flange couplings at each end of the spindle to 350-ft. lengths of shafting. A large number of motors will also be of the slow-speed type, for direct coupling to the shafting without the intervention of belts or gearing. The contract includes, in addition to the above, the necessary switchboard and auxiliary apparatus, various transformers and two jib cranes.

The Jandus Motor.—The Jandus Arc Lamp and Electric Co., Ltd., having made extensive additions to their plant, are now placing upon the market small motors. Many of the patented details of the new motor are claimed to be quite unique. The brush holders work in a fixed position at all loads; the patent terminals are of special design, being sunk in porcelain, and protected by a metal shield so that it is impossible to get a short circuit. The commutator has connections solid with the bars. The bearings are self-oiling; the armature is slotted, with former-wound interchangeable coils; and motors have either ventilated, or air-tight frames. The general design is of circular shape, forming a neat machine. It can be fixed to floor, wall or ceiling, and special brackets are supplied for fixing to iron columns in engineering works, &c. It is considered that the motor should appeal specially to supply companies and corporations for hiring-out purposes, on account of its low first cost and maintenance charges. Messrs. Drake & Gorham, Ltd., of 66, Victoria Street, S.W., who are the sole agents for the company, have issued a price list giving a clear and full specification. The motors are being manufactured in a few sizes only, large quantities being made for stock, and all deliveries are from stock. We are informed that special attention has been paid in the design to adapt the motors for workshop use. The weight is small, from the use of steel castings, and all motors may be altered in a few minutes to run at any angle. The low speeds and complete protection of the enclosed motor facilitate their adoption for machine-tool driving. The experience gained in manufacturing the company's well-known arc lamps will be applied to the manufacture of these motors, and it is felt that the sales of motors will rival that of their lamps, the steadily increasing sales of these having justified the acquisition of plant and premises sufficiently large to take up the manufacture of other specialities. The illustration shows a 1-H.P. protected motor.



SIDE AND END ELEVATIONS OF JANDUS 1-H.P. MOTOR.

The Magnetic Storm.—Dr. Glazebrook, director of the National Physical Laboratory, Old Deer Park, Richmond, Surrey, sends the following observations on the recent magnetic storm to the *Times* under date November 2nd:—"The Kew magnetic curves for the evening of October 30th and the early morning of the 31st ult. showed minor disturbances of an ordinary type. On the 31st, at about 6 hours 3 min. a.m., there appeared, simultaneously in the declination, horizontal force and vertical force curves, a sudden movement of the exceptional type which sometimes serves as precursor of a large magnetic storm. As is usual in such cases, the initial movement was comparatively small, the horizontal force increasing by about 1 part in 300, whilst the declination needle moved 7 min. of arc to the west. After a more gradual return to nearly the original values, there occurred, about 6.43 a.m., a much larger, but not so sudden movement, the horizontal force diminishing by about 1 part in 80, whilst the declination needle moved over half a degree to the west. The storm was most violent between 10 a.m. and 7 p.m. on the 31st, but there continued a large amount of magnetic disturbance until 4 a.m. on November 1st. The photographic traces from the Kew standard magnetographs went repeatedly off the sheet alike in declination, horizontal force and vertical force; but the whole extent of the declination movement seems to be shown by a magnetograph of smaller sensitiveness undergoing verification at the time. According to this instrument, the difference between the extreme positions of the declination needle amounted to no less than 2½°. As to the other elements, the horizontal force trace crossed the sheet from edge to edge between 10 a.m. and 2 p.m. on the 31st, representing a change of about $\frac{1}{25}$th of the entire horizontal force, whilst the vertical force changed by 1 part in 90 between 5 p.m. and 6 p.m. What the full range may have been in these two elements it is impossible, of course, to say, owing to the insufficient width of the photographic paper, but the magnetic storm is unquestionably the largest recorded at Kew since February 13-14th, 1892. The present storm is remarkable, not merely for the great range between the extreme values recorded for the several magnetic elements, but also for the extraordinary number of large and rapid oscillations of force."

Royal Society.—Among the papers read on Thursday, November 19th, was one by Dr. A. D. Waller, F.R.S., "Electrometer Records of Secreto-motor Changes."

The Manufacture of Electrolytic Bleaching Compounds.—Electrolytic processes are being frequently taken up by paper, pulp and textile manufacturers, particularly in the United States, for the production of bleaching powder and hypochlorite liquors used in these industries. The form of vat for the production of the latter is not yet fully determined, but varies considerably in different mills. In the States diaphragms are generally used, whereas in Europe the liquor is produced direct without the use of a diaphragm.

In the September number of *Electro-chemical Industries*, Dr. W. H. Walker, in dealing with this subject at length, shows that in practice the rate of increase of hypochlorite, as measured by the amount of electricity sent through the vat, is found to be a constantly decreasing quantity as the operation is continued. For this reason a large amount of energy is required to produce hypochlorite of sufficient strength for use in textile mills, and the direct process is a very inefficient one, whereas a much greater energy efficiency is obtained in the diaphragm method for the production of strong bleaching powder.

In the States a large proportion of the mills in question are pulp mills requiring a much stronger solution of bleaching liquor than those working comparatively finished products in Europe, and consequently for them the direct process becomes so costly as to necessitate the use of a diaphragm process. Where, however, only weak solutions of hypochlorites are required, the direct process can be brought into requisition with advantage. Dr. Walker points out that soluble bleaching liquors are far superior in their action upon textiles and all goods requiring a finish of delicate quality and pureness of colour; and, for this reason alone, some of the mills in the States are contemplating the adoption of the direct process for the manufacture of soluble hypochlorites, in spite of the somewhat heavier cost of production of solutions of the strength they require. The lower the cost of power, the smaller the difference in the relative costs of these two products becomes; and where water-power is already installed to supply electric energy to the mill, it is obvious that the direct process could be used with some considerable advantage.

A Large Water-Power Installation for Aluminium Production.—The large water-power installation of the Société Electro-Metallurgique Française lately erected at La Praz, in Savoie, is described in detail by Mr. F. C. Perkins in *Electricity* (New York) of October 14th. Aluminium is manufactured in these works by the Héroult process, and chrome steel is also made in a special type of electric furnace. The water-power is obtained from the River Arc, whose flow is very variable at different seasons. For this reason there are two different heads of water arranged for, one of 70 metres and the other of 30. The higher pressure is supplied from a dam about two miles up the stream, and the lower from another dam about three-fifths of a mile from the power house. The power house itself is a building about 400 ft. in length and 40 ft. wide, containing as many as 30 electrical machines with an aggregate power approaching 15,000 H.P. Most of these machines are of the horizontal type directly connected to horizontal turbines, each machine having a capacity of 350 H.P. and being of low voltage direct current type, constructed by the Compagnie de l'Industrie Electrique et Mechanique, of Geneva.

There are seven horizontal continuous current machines of the Thury type, having six, eight and ten pole-pieces, ranging up to 500 H.P. and working at a pressure of 110 volts. These machines are direct coupled to horizontal turbines working at 250 revolutions per minute. The single-phase alternator which supplies current to the steel furnace is of 500 H.P., with a frequency of 33 and voltage of 110, giving a current of 3,750 amperes with a speed of 25 revolutions per minute. The 16 field poles of this machine revolve within the armature, which is stationary. By varying the connections of the machine, it may be arranged to deliver current at a voltage of either 120 or 65, and so enables the furnace to be under better control.

Appointments Vacant.—Tramways general manager for Sheffield; assistant electrical engineer for Gibraltar (£200, rising to £250); tramway manager for Bolton at, £500.

THE CENTRAL STATION ENGINEER.

We are informed that the notice which appeared in our last issue stating that Mr. T. B. Naylor had been appointed successor to the late Mr. Marsh, at the Dudley electricity works, is incorrect.

Out of 70 applicants for the post of resident electrical engineer at Leek, the following have been selected to attend before the Electricity Committee:—Mr. J. R W. Grainge, London; Mr. A. France, London; Mr. P. M. Carr, Maidstone; and Mr. J. W. Hame, Wigan.

The second annual tea and social of the Leeds City Electric Lighting Department cricket club took place in the Gladstone Hall, Skilbeck Street, on Saturday, 7th inst. Mr. Dickinson (president) occupied the chair, and he urged the men to take up physical and mental culture, reading, &c., during the winter months. Mr. Dickinson presented the prizes as follows:—W. Merritt, first batting prize (alarm clock); T. Merritt, second batting prize (nickel-plated fruit dish); R. Rowntree, first bowling prize (leather portmanteau); W. Merritt, second bowling prize (pair of boots); G. Newby, fielding prize (timepiece). Mr. J. W. Mitchell's string band played for dancing, and a most enjoyable evening was spent; in fact, there has already been an application for tickets for next year.

Mr. R. C. Coxon, of Sunderland, has been appointed general clerk to the Bermondsey B.C. electric light undertaking. There were 22 applicants for the position.

Shrewsbury T.C. has increased the salary of Mr. Johnson, resident electrical engineer, from £300 to £350 a year.

On the occasion of the marriage, on 10th inst., of Mr. E. A. Barker, borough electrical engineer, Barnsley, and Miss A Blackwell, second daughter of Mr. J. Blackwell, Walsall, the staff of the Barnsley Corporation presented to Mr. Barker a valuable barometer; the public lighting staff presented him with a handsome timepiece.

NEW COMPANIES REGISTERED.

Alert Electrical Co., Ltd. (78,971).—This company was registered on October 29th, with a capital of £2,000 in £1 shares, to carry on the business of electricians, electrical engineers, producers of generators, accumulators, distributors and suppliers of electricity for light, heat, motive power, or otherwise, motor, motor car, motor cycle and bicycle manufacturers, india-rubber merchants, tire makers, &c. The subscribers are:—H. Lavy, 40, Park Lane, Clissold Park, N., electrical engineer, 50 shares; J. J. Govey, 2, Hilsea Street, N.E., clerk, 1 share; G. L. Abrahams, 4, Clifton Gardens, Maida Vale, W., gentleman, 1 share; H. D. Home, 15, Portland Road, Finsbury Park, N., insurance broker, 1 share; A. Harpurney, 6, Hillside Villas, Harcourt Road, Wood Green, N., clerk, 1 share; F. Lavy, 93, Finsbury Pavement, E.C., solicitor, 1 share; and T. North, 106, Fairlop Road, Leytonstone, shorthand writer, 1 share. No initial public issue. The number of directors is not to be less than two nor more than five; the first are H. Lavy and Mrs. A. E. J. Webber (each of whom may retain office while holding £200 shares or stock); ordinary qualification, £50; remuneration of permanent directors, £40 each per annum, with £104 extra for H. Lavy as chairman and managing director. Remuneration of ordinary directors as fixed by the permanent.

British L. M. Ericsson Manufacturing Co., Ltd. (79,061).—This company was registered on November 6th, with a capital of £200,000 in £1 shares, to acquire the business carried on in Great Britain and Ireland by the National Telephone Co., Ltd., and by Aktiebolaget L. M. Ericsson & Co. (under the name of L. M. Ericsson & Co., Ltd.), respectively as manufacturers and suppliers of machinery articles, apparatus and appliances in connection with telephones and telegraphs, to adopt agreements (1) dated October 15th, 1903, between the National Telephone Co., Ltd., of the one part, and P. Hammarskjold, on behalf for this company, of the other part; and (2) bearing same date between Aktiebolaget L. M. Ericsson & Co., of the one part, and the said P. Hammarskjold, for this company, of the other part, and to carry on the business aforesaid and that of manufacturers of all kinds of appliances and materials capable of being used in connection with electrical works or with generation, distribution, supply, accumulation and employment of electricity, manufacturers of and dealers in wires, cables, lines, gas and water meters, cash checks and controllers, scientific, surgical and other instruments, automatic and general machinery, electricians, electrical and mechanical engineers, contractors, suppliers of electricity for telegraphic and telephonic purposes and for light, heat, power or otherwise, &c. The first subscribers (each with one share) are:—A. Bostron, 5, Thulegatan, Stockholm, Sweden, managing director of a company; W. Montelius, 45, Ostermalmsgatan, Stockholm, Sweden, juris consulting of the State Bank; H. T. Cedergren, Drottninggatan, 47, Stockholm, Sweden, managing director; H. Johansson, 5, Thulegatan, Stockholm, Sweden, chief engineer; P. Hammarskjold, Temple Chambers, E.C., electrical engineer; C. S. Agnew, 5, Mount Street, Manchester, director; C. H. Robertson, Plas Newydd, Llangollen, North Wales, company director; J. Ferguson, Bart., M.P., 80, Cornwall Gardens, London; W. E. L. Gaine, 100, St. George's Square, S.W., general manager of a company; and G. Franklin, Imperial Chambers, Norfolk Row, Sheffield, company director. No initial public issue. The number of directors is not to be less than four nor more than eight, provided that so long as the issued capital shall consist only of the shares taken by the subscribers and those allotted in pursuance of the aforesaid agreements, the number shall be four only. The first directors are to be nominated by the vendors named on the said agreements, and each of the vendors shall, while holding 50,000 shares, retain the right to nominate and remove two directors, or while holding 25,000 shares, to nominate and remove one director. Remuneration of directors, £52 10s. each per annum; qualification (except nominated directors) £1,000. P. Hammarskjold is the first managing director with a salary of not less than £600 per annum, and may not be removed without the consent of the vendors named in the second agreement. Registered office: Byron House, 82—5, Fleet Street, E.C.

T. H. Wathes & Co., Ltd. (76,953).—This company was registered October 27th, with a capital of £3,000 in £1 shares, to adopt an agreement with T. H. Wathes for the acquisition of the business of an electric power, light and telephone engineer now carried on by him at 13, Belgrave Gate, Leicester, and to carry on the same and the business of electricians, mechanical and electrical engineers, manufacturers of and dealers in electric, steam and petrol motor-cars, suppliers of electricity for light, heat, motive power or otherwise, &c. The first subscribers (each with one share) are:—T. H. Wathes, 100, King Richard's Road, Leicester, electrician; G. E. B. Hales, 75, St. Saviour's Road East, Leicester, electrician; R. Wathes, 100, King Richard's Road, Leicester, dairyman; F. W. Goodess, 1, Friar Lane, Leicester, chemist; R. H. Wathes, 100, King Richard's Road, Leicester, dairyman; Mrs. M. Hales, Wyveru Hotel, Station Street, Leicester; and Miss L. M. Layton, Wyveru Hotel, Station Street, Leicester. No initial public issue. The number of directors is not to be less than two nor more than five; the first are H. T. Wathes and G. E. B. Hales; qualification, £250; remuneration as fixed by the company.

Light Cure and Electro-Therapeutic Institute, Ltd. (78,946).—This company was registered on October 27th, with a capital of £12,000 in £1 shares, to provide, furnish and maintain an establishment for the cure and relief of diseases and ailments by electrical and other kindred treatment, and to carry on the business of electric light bath proprietors, electricians, mechanical engineers, suppliers of electricity, manufacturers of and dealers in all apparatus and things required for the generation, distribution, supply, accumulation and employment of electricity, &c. The first subscribers (each with one share) are:—E. N. Walker, K.C., M.G., 52, Warwick Road, S.W.; J. W. Sidley, 2, Nassington Road, Hampstead, merchant; D. S. Ward, Sedom House, Harrogate, alderman; J. T. Shone, 36, Maitland Park Road, N.W., merchant; R. King, 11, Praed Street, W., dentist; W. J. Spratling, B.Sc., F.C., I.S., 74, Wickham Road, Brockley, S.E.; and P. V. Gibson, 54, New Broad Street, E.C., clerk. Minimum cash subscription 10 per cent. of the shares offered to the public. The number of directors is not to be less than 2 nor more than 12; the first are E. N. Walker, K.C.M.G., J. W. Sidley, D. S. Ward and J. T. Shone; qualification and remuneration as fixed by the company.

Sunderland District Electric Tramways, Ltd. (79,054).—This company was registered on November 5th, with a capital of £270,000 in £1 shares, to acquire the rights to construct a tramway or tramways in the neighbourhood of Sunderland, together with any tramway or works already constructed thereunder, with a view thereto to enter into an agreement between the Electric Conversion Syndicate, Ltd., of the one part, and E. N. Dawe (as trustee for this company) of the other part, to construct, lay down, equip, repair and maintain any tramway or tramways, to work the same by means of electrical, steam, animal or other power, and to carry on the business of tramway, railway, omnibus and motor-car proprietors, suppliers of electrical power and light, &c. The first subscribers are:—G. H. Raw, 28, Albert Court, S.W., chairman Natal—Zululand Railway Co., Ltd., 250 shares; Sir R. Lord, Kt., J.P., Highfield Hall, Gosforth, Newcastle-on-Tyne, 250 shares; A. H. Drew, Beech Lawn, Tonbridge, Kent, gentleman, 1 share; W. H. Priestley, 23, Austin Friars, E.C., secretary, 1 share; E. M. Loughborough, 45, Holland Park Avenue, W., gentleman, 1 share; M. J. Upcott, 188, Elm Park Mansions, Chelsea, S.W., articled clerk, 1 share; and F. W. Nobbs, 23, Austin Friars, E.C., accountant, 1 share. Minimum cash subscription, 150,000 shares. The number of directors is not to be less than three nor more than seven; the first are J. S. Barwick (director of the Weardale Steel and Coke Co., Ltd., and Easington Coal Co., Ltd.), Sir R. Lord, Kt., J.P., Sir R. D. Monorieff, Bart., G. H. Raw, and W. Sutton, J.P.; qualification, £250; remuneration, £250 each per annum (£300 for the chairman), and 5 per cent. of the profits available for distribution divisible (such percentage not to exceed £1,500 in any year).

St. Albans and District Electric Supply Co., Ltd. (79,078).—This company was registered on November 7th, with a capital of £25,000 in £1 shares, to carry on the business of suppliers of electricity, carriers of passengers and goods, electrical engineers, electricians, engineers, contractors, wharfingers, agents, manufacturers of and dealers in railway, tramway, electric, magnetic, galvanic and other apparatus, &c. The first subscribers (each with one share) are:—J. Raworth, Donington House, Norfolk Street, W.C., director of British Electric Traction Co., Ltd.; C. H. Dade, Donington House, Norfolk Street, W.C., secretary of B.E.T. Co., Ltd.; G. J. Somerville, Donington House, Norfolk Street, W.C., electrical engineer; G. R. Hulme, 43, Blackheath Park, S.E., electrical engineer; G. Offor, Peak Hill Villa, Sydenham, S.E., electrical engineer; A. D. Foster, 5, Stamford Mansions, Stamford Grove East, Upper Clapton, N., secretary; and W. L. Madgen, Victoria Works, Belvedere Road, S.E., electrical engineer. No initial public issue. The number of directors is not to be less than three nor more than seven; the subscribers are to appoint the first; qualification, one share; remuneration, £50 each per annum and 5 per cent. of the dividend paid on ordinary shares, divisible. Registered office: Donington House, Norfolk Street, Strand, W.C.

Western Electric Distributing Corporation, Ltd. (78,057).—This company was registered on November 5th, with a capital of £10,000 in £1 shares, to adopt an agreement with the Bristol Trust, Ltd., and to carry on the business of suppliers of electric light and power, electricians, electrical engineers, contractors, manufacturers, mechanical and chemical engineers, &c. The first subscribers are:—T. Kirkland, 17, Victoria Street, Westminster, civil engineer, 100 shares; S. Williams, 38, Parliament Street, Westminster, solicitor, 100 shares; E. J. Glyn, Newland Lodge, Ingatestone, Essex, gentleman, 500 shares; W. T. Pressland, Broad Sanctuary Chambers, Westminster, electrical engineer, 150 shares; S. Williams, Bristol Trust, Ltd., Shannon Court, Bristol, director, 1 share; T. Aucklebridge, 7, Grange Road, Gunnersbury, surveyor, 1 share; A. J. Fippard, Broad Sanctuary Chambers, Westminster, electrical engineer, 1 share; and D. S. Capper, 17, Victoria Street, Westminster, civil engineer, 1 share. No initial public issue. The number of directors is not to be less than two nor more than seven; the first are not named; qualification, 100 shares; remuneration as fixed by the company.

Electro Peat-Coal Syndicate, Ltd. (79,016).—This company was registered on November 3rd, with a capital of £500 in 70 "A" and 430 "B" shares of £1 each, to carry on the business of manufacturers of peat fuel, peat charcoal, and fibrous peat, wherein the raw material is subjected to the influence of electric current with or without the addition of minerals or chemicals, pape and millboard manufacturers, contractors, merchants, carriers, shippers, &c The first subscribers (each with one share) are:—S. Rowe, 8, Bucklersbury, E.C. solicitor; T. H. Head, 103, Gresham House, E.C., chartered accountant; E. F. Johnston, 29, Great St. Helens, E.C., secretary; E. Cattanach, 29, Great St. Helens, E.C., merchant; A. Russan, 46, Leadenhall Street, E.C., merchant; S. G. Cole, 1a, Fredericks Place, E.C., chartered accountant; and G. P. Carter, Reedham, Purley, Surrey, chartered accountant. No initial public issue. The number of directors is not to be less than two nor more than five; the subscribers are to appoint the first; qualification, five "A" shares.

OFFICIAL RETURNS OF ELECTRICAL COMPANIES.

Adams-Randall Telephone Patents Co., Ltd. (61,457).—Issue, on October 13th, of £250 debentures, part of series created April 22nd, 1899, to secure £10,000, charged on the company's property, including patents, patent rights and leasehold premises. Holders: London and Foreign Contract Corporation, Ltd., 65, New Broad Street, E.C. Trustee: F. Davies, 95—97, Finsbury Pavement, E.C. Previously issued of same series: £9,700.

Sherard Cowper-Coles & Co., Ltd., electricians, &c., London (67,136).—Issue, on October 19th, of £125 debentures, part of series created by resolutions of December 3rd, 1901, and February 7th, 1902, to secure £6,500, charged on the company's property, present and future, except uncalled capital. No trustees. Previously issued of same series: £6,275.

Bath Electric Tramways, Ltd. (74,278).—A mortgage or charge, dated October 19th, 1903, to secure £35,000, and further advances up to £92,500, with 7 per cent. interest, has been registered. Property charged (as a specific mortgage): The undertakings authorised by the Bath and District Light Railways Order, 1901, and the Bath Electric Tramways (Light Railway Extensions) Order, 1903, with all permanent ways, stations, power houses, generating stations, car sheds, rolling stock, cables, plant, equipment and rights appertaining thereto, any running powers or rights over other tramways or railways, certain leasehold land, buildings, fixed plant and machinery at Ladymead, St. Michael, Bath. (As a floating security): All the company's other assets, present and future, except uncalled or unpaid capital. Holders: Law Debenture Corporation, Ltd., 4i, Threadneedle Street, E.C.

Worcester Electric Traction Co., Ltd. (74,698).—A trust deed, dated October 22nd, 1903, to secure £10,000 debenture stock, has been registered. Property charged: All the company's assets, present and future. Trustees: Electric and General Investment Co., Ltd., 1—2, Great Winchester Street, E.C. The company has power to issue further debenture stock ranking *pari passu* up to half its issued capital.

H. Sutton & Co., Ltd., electrical engineers, London (78,377).—A debenture, dated October 19th, 1903, to secure £250, and a second debenture of like amount, both charged on the company's undertaking and property, present and future, including uncalled capital, have been registered. Holder (first debenture): G. A. Benton, 8, The Exchange, Muswell Hill, N. (Second debenture): W. E. Collingridge, Warwick Lodge, Hadley, near Barnet.

Edisonia, Ltd. (52,977).—Issue, on October 21st, of £10,000 second debentures, being the whole of a series created same date. Property charged: The company's undertaking and property, present and future, including uncalled capital. Holders: Edison-Bell Phonograph Co., Ltd., 39, Charing Cross Road, W.C. No trustees.

Royce, Ltd., electricians, &c., Manchester (63,871).—Issue, on October 23rd, of £400 debentures, part of series created March 27th, 1903, to secure £25,000, charged on the company's undertaking and property, present and future, excluding uncalled capital. Trustees: Law Guarantee and Trust Society, Ltd., 49, Chancery Lane, W.C. Previously issued of same series: £22,700.

Geo. Higginson & Co., Ltd., electrical and general engineers, London (78,189).—£500 debentures, created 12th, and dated October 27th, 1903, charged on the company's undertaking and property, present and future, including its uncalled capital (if any), have been registered. No trustees.

Primitiva Gas and Electric Lighting Co. of Buenos Aires, Ltd. (19,267).—An agreement, dated October 22nd, 1903, supplemental to trust deeds, dated May 31st and November 26th, 1901, to secure £600,000, has been registered. By the terms of this agreement, the first principal indenture and the second principal indenture are varied so far as may be necessary to give effect to an agreement dated August 12th, 1903, with the Deutsch Ueberseeische Elektricitäts-Gesellschaft, for the sale of the company's electric installation and lands, buildings, &c., in connection therewith. Trustees for first debenture holders: F. C. Norton, 2, New Square, Lincoln's Inn, W.C., and H. A. Trotter, 7, Mincing Lane, E.C.

Manufacturing Electric Co., Ltd. (78,568).—Issue, on October 15th, of £350 debentures, part of series created same date to secure £1,000, charged on the company's undertaking and property, present and future, including uncalled capital. No trustees.

Electric Danite Syndicate, Ltd. (76,275).—Issue, on October 29th, of £200 debentures, part of series created February 6th, 1903, to secure £1,000, charged on the present and future capital, goodwill and other assets of the company. Holders: R. J. Toleman and R. Prespecker, 22, Walbrook, E.C. No trustees. Previously issued of same series: £800.

Weston-super-Mare and District Electric Supply Co., Ltd. (62,366).—A trust deed, dated October 29th, 1903, to secure £35,000 debenture stock, has been registered. Property charged: The company's undertaking and property, present and future, including uncalled capital. Trustees: Electric and General Investment Co., Ltd., 1 and 2, Great Winchester Street, E.C. The company has power to issue further debenture stock ranking *pari passu* up to half its subscribed capital.

ELECTRICITY SUPPLY ACCOUNTS.

Hammersmith B.C. Electricity Supply.

We give herewith the returns of the Hammersmith electrical department for the year ending March 31st, 1903. Steady progress characterises the undertaking, as will be gathered from the following figures:—

Year.	Gross revenue.	No. of units.	Total cost per unit.	8-c.p. lamps connected.
1900	£13,660	891,301	2·09d.	30,131
1901	17,880	914,259	2·23d.	43,863
1902	22,148	1,461,427	2·17d.	45,422
1903	27,185	1,736,839	2·24d.	66,224

A slight decrease in the average selling price per unit is attributed to the increasing sale of energy at power rate. The growing motor load is, however, a satisfactory feature, which does not receive anything like the attention from the Borough Councils that it deserves.

Working expenses are slightly higher per unit than in the previous year, and this is perhaps the least satisfactory feature in the returns.

The prices charged are:—For private lighting, 6d. per unit for the first hour and 3d. after; and for power, 2½d. to 1½d., both on the maximum demand system.

General Statement.

For year ending March 31st—	1902.	1903.
Total capital expended	£173,802	£190,329
Number of units sold—		
Private supply	1,134,711	1,412,297
Public lighting	326,716	324,542
Total number of units sold	1,461,427	1,736,839
Equivalent No. of 8-c.p. lamps connected	45,422	66,224
H.P. of motors connected	74	396
Number of public lamps	214	239
Maximum load in kw.	1,176	1,320
Revenue account—		
Gross revenue	£22,148	£27,185
„ expenditure	£13,235	£16,255
„ profit	£8,913	£10,930
Average price obtained—		
Private lighting	3·77d.	3·68d.
Public lighting	2·85d.	2·94d.

Revenue Account.

	1903. Gross.	Per unit.
By sale of energy	£25,591	3·54d.
Meter and motor rents, attendance, repairs, compensation, tests, damages recovered, &c....	891	·12d.
Taxes and rates refunded	703	·09d.
Gross revenue	£27,185	3·75d.

Cost of Production.

	Gross.	Per unit.
Coal, and oil fuel	£5,082	·70d.
Oil, waste, water and engine room stores ...	723	·10d.
Wages incurred in generation and distribution	2,720	·37d.
Repairs and maintenance of buildings, machinery, and plant...	3,223	·44d.
Works and distribution costs	£11,748	1·61d
Repairs, attendance, &c., public lamps	1,118	·16d.
Rent, rates and taxes	1,385	·19d.
Management expenses, salaries of engineer and clerical staff	1,209	·17d.
General establishment charges, insurance, law, printing and stationery...	795	·11d.
Total works costs ...	£16,255	2·24d.

Profit Statement.

Interest on loans	£5,336
Sinking fund	4,514
Consumers' accounts written off	17
Balance, net profit for 1903	1,063
Gross profit ...	£10,930

A gross profit of £10,930 resulted on the year's working, and after meeting financial charges, &c., a balance of £1,063 remains. This surplus is, of course, abnormally increased by the inclusion of the items refunded in the revenue account.

The department has credited to a reserve fund the sum of £2,500 out of the accumulated net profit.

CITY NOTES.

West India and Panama Telegraph Co.

Mr. W. B. Kingsford presided at the half-yearly meeting held at Winchester House on Wednesday. In moving the adoption of the report, he said that the total receipts for the half-year were £34,903, as compared with £28,970 in the corresponding period of 1902, or a net increase of £5,933. This was almost entirely due to a windfall of abnormal traffic which came upon the lines in consequence of the interruption of two of the French West India Co.'s cables. Those two cables had now been repaired, and since the middle of October that extra source of revenue had ceased The startling political events which were taking place on the Isthmus of Panama had led to a certain amount of additional traffic which was at present passing over the Colon cable, and that fact might compensate in some measure for the loss of the French traffic. The expenses amounted to £23,051, as against £22,399, or a net increase of £652. That was arrived at by the increased cost of repairing cables, which was £302, and also the setting aside of £281 for depreciation (10 per cent. per annum for one month) of the new repairing ship. There were also sundry other increases at stations and in London It was proposed to pay 8s. per share on account of the arrears of dividend on the first preference shares, and the policy of the board would be to pay off the remaining arrears when the available profits enabled it to do so. On August 11th a great cyclone struck the island of Jamaica; enormous damage was done to buildings and other property. The Jamaica Government Telegraph landlines were completely wrecked, and this company's landlines between Kingston and Holland Bay—a distance of 52 miles—were also blown down, and in some places altogether disappeared. At Holland Bay the full force of the hurricane was felt, and the roof of the company's offices and staff dwelling-house was blown off, the cable hut was entirely carried away, and the cables leading into it were dislodged and disconnected. On the following day, Mr. de Mesa, the clerk-in-charge there, with great energy, managed to clear the cables, and succeeded in restoring the communication by the very smart and clever device of joining them up on the beach. Four days afterwards the *Henry Holmes* arrived on the spot, and at once set to work to repair the damage done to the cables. At the same time, Mr. McLeod, the clerk-in-charge at Kingston, was very actively engaged in restoring the landline. It was by events such as these that they were continually and painfully reminded that the maintenance of telegraphic communication throughout the West Indian Colonies was, in Falstaff's phrase, no boy's play, but a most arduous and anxious business. With 22 stations to be maintained, and 24 sections of cable, having a total length of about 4,600 miles, and with nearly 400 miles of landlines, the system was vulnerable over a very large area and at very many points. Consequently, in any disastrous convulsion of nature which took place in the West Indies, they were invariably found to be in the list of those who suffered. Under normal conditions their work was at all

times thick beset with difficulties. Taking into due account the difficulties, hindrances and discouragements which the company all through its career had had to face and overcome, he felt that it most assuredly deserved great commendation and no little credit for the resolute persistence with which for 30 years its burdensome and ill-requited task had been performed. The company had lately had considerable trouble with the cable from Trinidad to Demerara, the southern terminus of the system. They had two cables lying in those waters; one had been down for 30 or 32 years, and they had spent vast sums in repairing it from time to time. They always tried to take a cheery view of things; but, really, he feared that if the time had not yet come, it might come before long, when the board would have seriously to consider whether, in the company's financial position, it would be justified in spending further money in endeavouring to put it into good working order. It was laid upon a new route which was specially and most carefully selected, in the hope that they might find a better sea-bottom upon which the cable might rest in greater security. This new route was longer and more expensive than the other one, but it had, unfortunately, proved to be little or no better than the old one. It was quite evident that the mud in which a portion of the cable had of necessity to be laid contained some destructive property which by chemical action corroded the iron armour of the cable and so weakened it that a break not infrequently occurred. Some little while ago the board gave instructions to the cable staff in the West Indies that all weak places in the cable, met with during repairing operations, were to be cut out and replaced by entirely new cable. The interruptions were due to no default whatever either on the part of the company or in the cable, but simply and solely to physical causes over which they had absolutely no control. From St. Vincent came the welcome and encouraging intelligence that the inhabitants, even the most pessimistic of them, were beginning to feel that the volcanic disturbances were now over, and they were eagerly looking to the authorities to take active and energetic measures to restore the industries of the island. After going into some of the phases of industrial outlook in the West Indies, the chairman concluded his most interesting speech, of which this is necessarily a curtailed account, by formally moving the adoption of the report.

This, after a few questions had been asked and answered, was carried unanimously, and a vote of thanks to the board was coupled with a suggestion that the staff abroad who had acted so splendidly in the recent serious emergencies should receive some additional recognition.

Companies Struck Off the Register.

The following have been struck off the Register of Joint Stock Companies, and are accordingly dissolved:—

British Motor Traction Co., Ltd.
British Volta Electric Glow Lamp Co., Ltd.
Collier-Marr Telephone and Electrical Manufacturing Co., Ltd.
Electric Arms and Ammunition Syndicate, Ltd.
General Traction Co., Ltd.
International Electric Storage, Ltd.
Lithanode Electric Storage Co., Ltd.
Universal Electric Lighting Co., Ltd.
Western Telegraph Co., Ltd.
Woking Sanitary Electric Laundry Co., Ltd.

Ferranti, Ltd.

A meeting of the creditors of Ferranti, Ltd., was held at Winchester House, Old Broad Street, on Wednesday, for the purpose of explaining the present position of the company, and appointing a committee to confer with the directors of the company, and the receivers and managers for the debenture stockholders, with a view to presenting a scheme of reconstruction for the approval of the debenture stockholders, creditors and shareholders of the company.

After lengthy discussion, it was resolved: "That it is not in the interests of the creditors that the company should be compulsorily wound up."

The following gentlemen were then chosen to act on a committee to confer with the directors and receivers and managers for preparing a scheme for reconstruction or reorganisation:—Messrs. Lamb, Bamford, Nalder, Henderson, Taylor, G. Schultz, Kolle (Babcock & Wilcox), Brotherton, Estler and Bergtheil.

Stock Exchange Notices.—Applications have been made to the Committee to appoint a special settling day in and to grant a quotation to:—Dick, Kerr & Co., Ltd.—52,000 ordinary shares of £5 each, fully paid, Nos. 1 to 52,000; 61,000 6 per cent. cumulative preference shares of £5 each, fully paid, Nos. 1 to 61,000; and £300,000 4½ per cent. debenture stock; Havana Electricity Co., Ltd.—15,000 shares of £10 each. The Committee has ordered the undermentioned securities to be quoted in the Official List:—Eastern Telegraph Co., Ltd.—Further issue of £44,435 3½ per cent. preference stock. Midland Electric Corporation for Power Distribution, Ltd.—£250,000 4½ per cent. first mortgage debentures, Nos. 1 to 1,750 of £100 each, and 1,751 to 1,900 of £500 each.

The Castner-Kellner Alkali Co.—A financial contemporary states that the interim dividend has had to be passed this time. Last year there was a 6 per cent. dividend notwithstanding the falling off of £9,000 in the net profit.

South Lancashire Electric Traction and Power Co.—A meeting of debenture stockholders in the above-named company was held at Liverpool on Friday afternoon last.

STOCKS AND SHARES.

Wednesday Evening.

Brightness of a novel kind has been imparted to the tone of Stock Exchange markets as a whole by a recurrence of decidedly better prices in some of the speculative sections. Consols, too, improved upon option dealings, although the better feeling in this market failed to galvanise Home Railway stocks into semblance of firmness. Electricity Supply shares look on quietly, almost unaltered as to prices, and the Telegraph section shows several further advances as against a trio of falls. Manufacturing shares have come on offer this week, and the prices were marked down almost mechanically.

City and South London Ordinary is a point lower, the traffic again being a poor one. The present price of 51 is the flattest recorded for the past two years: in 1901 it went to 46, which, in its turn, formed the low-water mark since 1896, when 40 was the minimum. At the other end of the scale, the highest price recorded was 80½ last year, so that the fall has been practically 30 points within a twelvemonth. Doubtless the 80½ level was an inflated one, but such a heavy slump rather leads to the assumption of some kind of reaction, which, however, it would be vain to expect so long as the receipts are steadily decreasing. Central Londons and Waterloo and City stocks have not altered, but a little attention is being turned towards Great Northern and City Preferred shares, now standing at 8, it being stated that part of the line should be open for traffic in January. We seem to have distant remembrance of postponements of this event before.

Districts are 31, and Metropolitans 84. It is said that the District Debenture issue was subscribed several times over, but in the market some brokers declare that clients of theirs who applied got an allotment in full. No premium is quoted on the new stock, and the price of the old remains about 104½, business being done at that price the other day.

In the traction market, Cape Electrics are being freely dealt in on the basis of 1⅞ to 2. Anglo-Argentines are ⅛ up at 4⅝, and Calcutta Trams have hardened to 7, the same price as that quoted for Calcutta Electric Supply shares. In connection with these last, a mistake in regard to quoting old and new shares together in the Stock Exchange *Official List* has led to loss on the part of those who deal in them. By some unexplainable error, the old shares, with their dividend of 3s., were quoted alongside of the new, which were carrying only 2s. 2d. dividend, and the consequence was a loss of 10d. per share to the unfortunate jobbers who dealt in the different shares while the books were closed, and before the price went *ex* dividend.

Anglo-American Telegraph stocks have lost part of their last week's strength upon sales by proprietors who were only waiting for some such rise to enable them to get out. The Deferred stock is down ½, and the Preferred 1 per cent, but the Ordinary continues unaltered. Elsewhere, telegraph securities are firm, and there are several advances of a point amongst the gilt-edged varieties. West India and Panama have improved upon their rise of a week ago, and this time both the Ordinary and the Second Preference participate in the advance. Now that the First Preference are receiving arrears of dividend, it is thought possible that some day even the Seconds may get at least a part of the 6 per cent. due to them, and the price is still 50 per cent. below the par value of the shares. Western Telegraphs, nominally ¼ easier, are actually unchanged, being now *ex* dividend and bonus.

Amongst manufacturing shares the tone, as already mentioned, is heavy, and both Callender's Ordinary and British Insulated Ordinary have relapsed. The former lost the advance recently made, and the demand which put up the price has given way to a few selling orders. Westinghouse Preference are easier at 5½. Electric Construction Debenture was done at 99½ on Tuesday, but electric shares generally are almost without fluctuation. City of London Ordinary have put on ¼, London Electric Preference have lost another 5s., and Urban Preference at 5 are ¼ up. Folkestone at 5⅞ are ¼ off. These are practically the only changes to be noted in the list, and represent very little business.

No new issues of importance call for notice, but an offer of prior lien gold bonds by the Montreal Water and Power Co. points to the extension of the electric railway system which is constantly going on in that city as an important factor in the growth of the company's franchise territory. The prospectus also calls attention to the electric power pump it possesses at Westmount, having a daily capacity of 4½ million gallons. In mentioning which, it may be added that British Columbia Electric Railway Ordinary stock has hardened to 82½ *ex* dividend, although the price of the Preferred at 94½ still carries its 2½ per cent. for the half-year.

SHARE LIST OF ELECTRICAL COMPANIES.

TELEGRAPH AND TELEPHONE COMPANIES.

Present Issue.	NAME.	Stock or Share. ‡	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Nov. 11th.	Closing Quotations Nov. 18th.	Business done week ended Nov. 18th, 1903. Highest	Lowest
67,100	African Direct Telegraph, 4 % Debs.	100	..	..	..	99 —103	99 —103	..	..
25,000	Amazon Telegraph Co.'s shares, Nos. 1 to 25,000	10	..	..	..	2½ — 3½	2½ — 3½	..	..
119,700£	Do. do. 5 % Debs., Nos. 1 to 1,250 Red.	100	..	..	..	70 — 80	70 — 80	..	..
788,840	Anglo-American Telegraph	Stock	3½%	6l.s.	6o/6	49 — 52	49 — 52	50½	49
3,105,580	Do. do. do. 6 % Pref.	Stock	6 %	6 %	6 %	93 — 95	92 — 94	94½	93
3,105,580	Do. do. do. Deferred	Stock	5s. %	2s.	1/-	3½ — 1½	7½ — 8½	8½	..
44,000	Chili Telephone, Nos. 1 to 44,000	5	5 %	5 %	6 %	4½ — 5½	4½ — 5½	..	..
13,333,300$	Commercial Cable	$100	8 %	8 %	8 %	145 —155	145 —155	..	..
1,841,209	Do. do. Sterling 500 year 4 % Deb. Stock Red.	Stock	..	..	..	90 — 93	90 — 93	92½	91
16,000	Cuba Telegraph	10	4½%	4 %	6½%	7 — 8	7 — 8	7½	7¼
6,000	Do. 10 % Pref.	10	..	..	..	16 — 17	16 — 17	..	..
12,931	Direct Spanish Telegraph	5	4 %	4 %	4 %	2½ — 3½	2½ — 3½	..	..
6,000	Do. do. 10 % Cum. Pref.	5	..	..	..	7 — 8	7 — 8	..	..
90,000	Do. do. 4½ % Debs.	50	..	..	..	96 —100	97 —101	..	..
60,710£	Direct United States Cable	20	3½%	3½%	3½%	10½ — 10¾	10½ — 10¾	10¾	10⅝
87,800	Direct West India Cable, 4½% Reg. Deb., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
4,000,000	Eastern Telegraph, Ord. Stock	Stock	7 %	7 %	7 %	122 —127	122 —127	123¾	122
1,955,555	Do. 8½ % Pref. Stock	100	..	..	..	86 — 89	85 — 88	86½	..
1,584,645	Do. 4 % Mort. Deb. Stock Red.	Stock	..	..	..	105 —108	105 —108	106¾	..
800,000	Eastern Extension, Australasia, and China Telegraph	10	7 %	7 %	7 %	11½ — 12	11 — 1½	11⅞	11½
820,000£	Do. 4 % Deb. Stock	Stock	..	..	..	105 —108	105 —108	..	..
800,000	Eastern & South African Tele., 4% Mt. Db., Nos. 1 to 8,000, red. 1909	100	..	..	..	99 —102	99 —102	..	..
200,000£	Do. do. 4 % Reg. Mort. Debs. (Mauritius Sub.) 1 to 8,000	25	..	..	..	98 —101 %	99 —102	101½	100
180,227	Globe Telegraph and Trust	10	5½%	5½%	..	8½ — 9	8½ — 9	8¾	8⅝
180,042	Do. do. 6 % Pref.	10	..	..	..	12½ — 13	12½ — 13	12¾	12½
150,000	Great Northern Telegraph, of Copenhagen	10	15 %	15 %	12½%	22½ — 23½	22½ — 23½	23	22⅝
62,500£	Halifax and Bermudas Cable, 4½ % 1st Mort. Debs., within Nos. 1 to 1,200, Red.	100	..	..	..	99 —102	99 —102	..	..
17,000	Indo-European Telegraph	25	10 %	10 %	10%	36 — 39	36 — 39	..	..
100,000£	London Platino-Brazilian Telegraph, 6 % Debs.	100	..	..	..	98 —102	98 —102	..	..
1,988,333	National Telephone, Pref. Stock	100	5 %	5 %	6 %	100 —102	101 —103	101⅜	100½
1,966,667	Do. do. Def. Stock	100	..	..	4½%	74 — 76	74 — 76	75½	74½
15,000	Do. do. 6 % Cum. 1st Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	..	..
15,000	Do. do. 6 % Cum. 2nd Pref.	10	6 %	6 %	6 %	13 — 14	13 — 14	13⅞	13⅝
2,250,000	Do. do. 5 % Non-cum. 3rd. Pref., 1 to 250,000	5	5 %	5 %	5 %	5 — 5¼	5 — 5¼	5 3/16	..
000,000£	Do. do. 3½ % Deb. Stock Red.	Stock	3½%	3½%	3½%	93 — 95	94 — 96	95	..
600,000	Do. do. 4 % Deb. Stock Red.	100	4 %	4 %	4 %	102 —104	102 —104	102½	..
179,313	Oriental Telephone and Elec. Nos. 1 to 171,504, fully paid	1	6 %	6 %	6 %	13/16 — 15/16	13/16 — 15/16	..	..
50,000	Do. do. 6 % Cum. Pref.	1	..	..	..	1 — 1⅛	1 — 1⅛	..	..
100,000£	Pacific and European Tel., 4 % Guar. Debs., 1 to 1,000	100	..	..	..	97 —100	97 —100	..	..
11,889	Reuter's	8	5 %	5 %	..	6¾ — 7¼	6¾ — 7¼	..	..
3,808	Submarine Cables Trust	Cert.	..	..	..	116 —121	115 —120	..	..
58,000	United River Plate Telephone	5	7 %	7 %	7 %	5¾ — 6	5¾ — 6	..	..
40,000	Do. do. 5 % Cum. Pref., Nos. 1 to 40,000	5	..	..	..	4¾ — 5¼	4¾ — 5¼	..	..
179,947£	Do. do. 5 % Debs.	Stock	..	..	..	104 —107	104 —107	..	..
15,609	West African Telegraph, Shares	10	..	..	2 %	5 — 6	5 — 6	..	..
150,000£	West Coast of America, 4% Debs., 1 to 1,500 guar. by Braz. Sub. Tel.	100	..	..	..	95 — 98	95 — 98	95	..
967,980	Western Telegraph, Ltd., Nos. 1 to 307,980	10	7 %	7 %	7 %	12 — 12½	11⅞ — 12¼	12 1/16	12
75,000£	Do. do. 5 % Debs. 2nd series, 1906	100	..	..	..	100 —103	100 —103	..	..
400,000	Do. do. 4 % Deb. Stock Red.	100	..	..	..	98 —101	98 —101	..	..
88,891	West India and Panama Telegraph	10	½%	..	..	3/16 — ¼	1/16 — 3/16	..	..
34,553	Do. do. do. 6 % Cum. 1st Pref.	10	..	..	..	6¼ — 6½	6¼ — 7 1/16	6⅜	6 1/16
4,669	Do. do. do. 6 % Cum. 2nd Pref.	10	..	..	..	3½ — 4½	4 — 5	..	..
80,000£	Do. do. do. 5 % Debs., Nos. 1 to 1,800	100	..	..	..	101 —104	101 —104	..	..

ELECTRICAL RAILWAY, MANUFACTURING AND INDUSTRIAL COMPANIES.

20,000	British Aluminium 7 % Cum. Pref.	10	..	..	..	4½ — 5½	4½ — 5½	..	..
800,000£	Do. do. 5% 1st Mort. Deb. Stock Red.	Stock	..	..	..	85 — 89	85 — 89	..	..
100,000	British Electric Traction	10	9 %	9 %	8 %	11½ — 12	11½ — 12	11⅜	..
100,000	Do. do. 6 % Cum. Pref.	10	..	..	..	11 — 11½	11 — 11½	11⅜	11 1/16
600,000£	Do. do. 5 % Perpetual Debenture Stock	Stock	..	..	..	120 —123	120 —123	122½	122¼
100,000	British Insulated and Helsby Cables	5	15 %	10 %	10 %	6½ — 6¾	6 — 6¼	..	..
100,000	Do. do. 6 % Cum. Pref.	5	..	..	..	5¼ — 5⅜	5¼ — 5⅜	..	..
50,000	Do. do. 4½ % 1st Mort. Deb. Red.	100	..	..	..	102 —105	102 —105	..	..
50,000	¶Browett, Lindley & Co., Ord.	£1	8 %	Nil	..	3/16 — ¼	3/16 — ¼	..	..
50,000	¶ Do. do. 6 % Cum. Pref.	£1	6 %	6 %	..	14/6 to 15/6	14/6 to 15/6	..	..
105,731	Brush Electrical Engineering, Ord., 1 to 105,731	2	5 %	Nil	Nil	¾ — 1	¾ — 1	..	..
150,000	Do. do. Non-cum. 6 % Pref.	2	6 %	3 %	6 %	1¼ — 1½	1¼ — 1½	..	..
125,000£	Do. do. 4½ % Perp. Deb. Stock	Stock	..	..	..	97 —100	97 —100	..	..
125,000£	Do. do. 4½ % Perp. 2nd Deb. Stock	Stock	..	..	..	85 — 90	85 — 90	..	..
35,000	Callender's Cable Construction shares	5	15 %	20 %	15 %	11½ — 12½	11 — 12	..	..
40,000	Do. do. do. 5 % Cum. Pref.	5	..	..	..	5¼ — 5¾	5¼ — 5¾	..	..
90,000£	Do. do. do. 4½ % 1st Mort. Deb. Stock Red.	Stock	..	..	..	106 —110	106 —110	..	..
1,860,014	Central London Railway, Ord. Stock	Stock	..	4 %	4 %	93 — 96	93 — 96	..	..
494,098	Do. do. 4 % Pref. Stock	Stock	..	4 %	4 %	99 —102	99 —102	..	..
494,998	Do. do. Def. do.	Stock	..	4 %	4 %	99 —102	99 —102	..	..
1,330,000	City and South London Railway	Stock	1½%	2 %	3½%	51 — 53	50 — 52	..	..
85,000	Crompton & Co., Nos. 1 to 85,000	8	8 %	7½%	5 %	1¾ — 2¼	1¾ — 2¼	..	..
100,000£	Do. 5 % 1st Mort. Reg. Debs., to 900 of £100, and 901 to 11,000 of £50 red.	..	..	..	..	100 —104	100 —104	..	..
99,261	Edison & Swan United Elec. Light, "A" shares, £8 paid, 1 to 99,261	-	2½%	Nil	..	0 — ¼	0 — ¼	..	..
17,139	Do. do. "A" shares, 01—017,139	-	2½%	Nil	..	1 — 2	1 — 2	..	..
844,023£	Do. do. 4 % Deb. Stock Red.	100	..	..	..	72 — 77	72 — 77	73	..
100,000£	Do. do. 5 % 2nd Deb. Stock Prov. Certs. all pd.	100	..	..	..	76 — 81	76 — 81	..	..
112,100	Electric Construction, 1 to 112,100	2	6 %	6 %	6 %	1½ — 1¾	1½ — 1¾	..	..
31,390	Do. do. 7 % Cum. Pref., 1 to 31,390	2	..	..	..	2½ — 3	2½ — 3	..	..
82,500£	Do. do. 4 % Perp. 1st Mort. Deb. Stock	Stock	..	..	..	97 —100	97 —100	99½	..
25,000	General Electric Co. (1900), 5 % Cum. Pref.	10	5 %	5 %	5 %	9½ — 10¼	9½ — 10¼	..	..
200,000	Do. do. 4 % Mort. Deb.	Stock	..	..	..	96 — 99	96 — 99	..	..
35,000	Henley's (W. T.) Telegraph Works, Ord.	5	20 %	20 %	20 %	14 — 15	14 — 15	..	..
35,000	Do. do. 4½ % Pref.	5	4½%	..	..	5 — 5¼	5 — 5¼	5¼	..
48,050	Do. do. 4½ Mort. Deb. Stock	Stock	..	..	..	108 —112	108 —112	..	..
50,000	India-Rubber, Gutta-Percha & Telegraph Works	10	10 %	10 %	10 %	18½ — 19½	18 — 19	18⅛	18¾
800,000£	Do. do. do. 4 % 1st Mort. Deb.	100	..	..	..	100 —103	100 —103	100½	..
37,500	†Liverpool Overhead Railway, Ord.	10	2½%	1½%	1½%	4¼ — 4½	4½ — 4¾	..	..
10,000	† Do. do. Pref. £10 paid	10	..	..	..	10¾ — 10¾	10¾ — 10¾	..	..
37,350	Telegraph Construction and Maintenance	12	17½%	20 %	20 %	34 — 37	34 — 37	34½	..
150,000£	Do. do. 4 % Deb. Bds., Nos. 1 to 1,500 Red. 1909	100	..	..	..	101 —104	100 —103	..	..
540,000£	Waterloo & City Railway, Ord. Stock	100	3 %	3 %	3½%	91 — 94	91 — 94	..	..

† Quotations on Liverpool Stock Exchange. ‡ Unless otherwise stated all shares are fully paid. ¶ From Manchester Share List.

Bank rate of discount 4 per cent. (September 3rd, 1903).

SHARE LIST OF ELECTRICAL COMPANIES (*continued*).—ELECTRICITY SUPPLY COMPANIES.

Present issue.	NAME,	Stock or Share.	Dividends for the last three years. 1900.	1901.	1902.	Closing Quotations Nov. 11th.	Closing Quotations Nov. 18th.	Business done week ended Nov. 18th, 1903. Highest	Lowest
100,000	Blackheath and Greenwich Dist. Electric Light, Ord.	‡	..	..	..	⅜ — ⅞	⅜ — ⅞	..	..
100,000	Do. 4½% 1st Deb. Stock, Prov. Certs.	1	..	..	..	116 —119	116 —119	..	..
20,000	Brompton & Kensington Electric Light Sup., Ord., 1 to 20,000	100	..	..	..	10½ — 10⅝	10½ — 10⅝	..	..
20,000	Do. do. 7 % Cum. Pref.	5	6 %	8 %	8 %	10 — 10¼	10 — 10¼	..	..
50,000	Charing Cross and Strand Electricity Supply	5	..	..	..	..	..	..	..
70,000	Do. do. do. 4½% Cum. Pref.	5	9 %	10 %	10 %	9 — 9¼	9 — 9⅜	9⅜	9⅛
40,000	Do. do. "City Undertaking" 4½% Cum. Pref.	5	..	..	..	5¼ — 5⅜	5¼ — 5⅜	5⅜	..
250,000	Do. do. 4 % Deb. Stock Red.	5	..	..	..	4⅜ — 5	4⅜ — 5	..	..
44,436	*Chelsea Electricity Supply, Ord.	100	..	..	..	104 —105	104 —106	..	..
150,000£	Do. do. % Deb. Stock Red.	5	5½%	4 %	4½%	5½ — 6	5½ — 6	..	..
70,595	City of London Electric Lighting, Ord. 40,001—110,595	Stock	..	..	..	108 —111	107 —110	..	..
40,000	Do. 6 % Cum. Pref., 1 to 40,000	10	0 %	5 %	5 %	9⅜ — 10¼	10 — 10⅛	10⅜	10½
400,000£	Do. 5 % Deb. Stock, Scrip. (iss. at 115) all paid	10	6 %	..	..	13 — 14	13 — 14	13½	..
800,000	Do. 4½% 2nd Deb. Stock, Prov. Certs., all paid	..	..	..	..	122 —127	122 —127	..	..
40,000	County of London & Brush Prov. Electric Lighting, Ord. 1—40,000	100	..	..	..	102 —105	102 —105	..	..
20,000	Do. do. do. 6 % Pref., 40,001—60,000	10	4 %	4 %	4 %	7½ — 8½	7½ — 8½	..	..
400,000£	Do. do. 4½% Deb. Stock	10	..	..	..	11⅜ — 12⅝	11⅜ — 12⅝	..	..
250,000	Do. do. 4½% 2nd Deb. Stock	..	..	..	..	107 —110	107 —110	..	..
50,000	Edmundson's Electric Corporation, Ord. Shares	Stock	..	..	..	99 —102	99 —102	100½	100⅜
30,000	Do. do. 6 % Cum. Pref.	5	7 %	7 %	7 %	6¼ — 6⅜	6¼ — 6⅜	..	..
140,000	Do. do. 4½% 1st Mort. Deb. Stock	..	..	..	..	6 — 6½	6 — 6⅜	6½	..
21,000	Kensington and Knightsbridge Electric, Ord.	100	..	..	..	104 —107	104 —107	..	..
90,000	Do. do. do. 4 % Debenture Stock	5	12 %	10 %	10 %	10½ — 11½	10½ — 11½	..	..
110,000	London Electric Supply Corporation, Limited, Ord.	Stock	..	..	..	101 —104	101 —104	..	..
42,840	Do. do. do. 6 % Pref.	8	..	..	..	1⅞ — 2⅛	1⅞ — 2⅛	..	..
250,000£	Do. do. do. 4 % 1st Mort. Deb. Stock Red	5	..	..	..	5 — 5⅛	4⅞ — 5⅛	..	..
100,000	Metropolitan Electric Supply, 1 to 100,000	Stock	..	..	..	98 —101	98 —101	100⅛	99½
71,106	Do. do. 4½% Cum. Pref. 1—71,106, £3 paid	10	6 %	6¾%	7½%	17 — 18	17 — 18	17⅝	17⅛
220,000£	Do. do. 4½% 1st Mort. Deb. Stock	5	..	..	..	4⅛ — 4⅜	4⅛ — 4⅜	4⅛	4⅛
250,000£	Do. do. 3½% Mort. Deb. Stock Red	..	..	..	..	110 —114	110 —114	..	..
10,852	Notting Hill Electric Lighting	Stock	..	..	..	96 — 99	96 — 99	..	..
40,000	St. James' and Pall Mall Electric Light, Ord.	10	7 %	6 %	6 %	12½ — 13½	12½ — 13½	..	..
20,000	Do. do. do. 7 % Pref. 20,081 to 40,080	5	14½%	14½%	14½%	14⅜ — 15⅝	14 — 15	14⅞	14⅜
150,000£	Do. do. do. 3½% Deb. Stock Red	5	..	..	..	8 — 9	8 — 9	..	..
12,000	Smithfield Markets Electric Supply, Ord.	100	..	..	..	97 —100	97 —100	100	99½
50,000	Do. do. do. 4 % Deb. Stock	5	..	..	2½%	3 — 3½	5 — 5½	..	..
65,000	South London Electricity Supply, Ord.	Stock	..	..	..	— —	85 — 90	..	..
30,000	Urban Electric Supply, Ord.	5	..	..	1½%	3½ — 4	3½ — 4	..	..
80,000	Do. do. 5 % Cum. Pref.	5	..	..	..	4⅜ — 5⅛	4⅜ — 5⅛	..	..
110,000	Westminster Electric Supply, Ord.	5	..	..	..	4⅜ — 5	4⅜ — 5⅛	5	4⅜
28,141	Do. do. 5 % Cum. Pref.	5	10½%	10½%	12 %	12 — 13	12 — 13	12⅜	12
		5	..	..	..	6 — 6½	6 — 6½	..	..

* Subject to Founders Shares. ‡ Unless otherwise stated all shares are fully paid.

MARKET QUOTATIONS, Wednesday, November 18th.

CHEMICALS, &c.		Latest Price.	Week's Inc. or Dec.
a Acid, Hydrochloric	per cwt.	5/-	..
a ,, Nitric	per cwt.	22/-	..
a ,, Oxalic	per cwt.	32/-	..
a ,, Sulphuric	per cwt.	5/6	..
a Ammoniac, Sal	per cwt.	42/-	..
a Ammonia, Muriate (crystal)	per ton	£33 10	..
a ,, ,,	per ton	£30	..
a Bleaching powder	per ton	£4 10	..
a Bisulphide of Carbon	per ton	£15	..
a Borax	per ton	£18	..
a Benzole (90 %)	per gal.	7/-	..
a ,, (50/90 %)	per gal.	5/6	..
a Copper Sulphate	per ton	£20	..
a Lead, Nitrate	per ton	£24	..
a ,, White Sugar	per ton	£31	..
a ,, Peroxide	per ton	£27 10	..
a Methylated Spirit	per gal.	2/6	..
a Naphtha, Solvent (90% a 160° C).	per gal.	5/6	..
a Potash, Bichromate, in casks	per lb.	8d.	..
a ,, Caustic (75/80%)	per ton	£24	..
a ,, Bisulphate	per ton	£35	..
a Shellac	per cwt.	223/-	..
a Sulphate of Magnesia	per ton	£4 10	..
a Sulphur, Sublimed Flowers	per ton	£6 10	..
a ,, Recovered	per ton	£5 10	..
a ,, Lump	per ton	£5	..
a Soda, Caustic (white 70 %)	per ton	£10 15	..
a ,, Crystals	per ton	£3	..
a ,, Bichromate, casks	per lb.	2½d.	..

METALS, &c.			
b Aluminium Ingots, in ton lots	per ton	£130	..
b ,, Wire, in ton lots	per ton	£168	..
b ,, Sheet, in ton lots	per ton	£166	..
p Babbitt's metal ingots	per ton	£48 to £130	..
c Brass (rolled metal 2' to 12') basis	per lb.	6¾d.	½d. dec.
c ,, Tube (brazed)	per lb.	8¾d.	¼d. dec.
c ,, ,, (solid drawn)	per lb.	7¼d.	¼d. dec.
c ,, Wire, basis	per lb.	7d.	¼d. dec.
c Copper Tubes (brazed)	per lb.	9½d.	¼d. dec.
c ,, ,, (solid drawn)	per lb.	9¼d.	¼d. dec.
g Copper Bars (best selected	per ton	£71	£2 dec.

METALS, &c. (*continued*).		Latest Price.	Week's Inc. or Dec.
g Copper Sheet	per ton	£71	£2 dec.
g ,, Rod	per ton	£71	£2 dec.
c ,, (Electrolytic) Bars	per ton	£65	£2 dec.
c ,, ,, Sheets	per ton	£75	£2 dec.
c ,, ,, Rod	per ton	£67	£2 dec.
c ,, ,, H.C. Wire	per lb.	8d.	¼d. dec.
f Ebonite Rod	per lb.	3/8	..
f ,, Sheet	per lb.	8/-	..
n German Silver Wire	per lb.	1/6	..
h Gutta-percha fine	per lb.	8/-	..
h India-rubber, Para fine	per lb.	3/10 to 3/11	dec.
i Iron, Charcoal Sheets	per ton	£18	..
i ,, Pig (Cleveland warrants)	per ton	42/10	..
i ,, Forgings, according to size	per ton	From £11	..
i ,, Scrap, heavy	per ton	47/6 to 50/-	..
i ,, Wire, galvanised No. 8	per ton	£9 15	..
g Lead, English Ingot	per ton	£11 7 6 to £11 10	..
g ,, ,, Sheet	per ton	£13	..
m Manganin Wire No. 28	per lb.	8/-	..
g Mercury	per bot.	£8 7 6	..
d Mica (in original cases) small	per lb.	4d. to 1/6	..
d ,, ,, ,, medium	per lb.	2/6 to 3/9	..
d ,, ,, ,, large	per lb.	4/- to 7/9	..
p Phosphor Bronze, plain castings	per lb.	1/- to 1/2½	..
p ,, rolled bars & rods	per lb.	1/- to 1/3	..
p ,, ,, strip & sheet	per lb.	From 1/1	..
o Platinum	per oz.	£4	..
p Silicium Bronze Wire	per lb.	9d. to 11d.	..
i Steel, Magnet, acc'd'g to desc'p'n	per ton	£58	..
i ,, ,, in bars		£15 to £40	..
g Tin, Block	per ton	£120 to £121	10/- inc.
g ,, Foil	per lb.	1/6	..
n ,, Wire, Nos. 1 to 16	per lb.	1/7	..
p White Anti-friction Metals— "White Ant" brand	per ton	£42 to £62	..
j Yarns, 2/10s Grey Cotton, on sp'ls	per lb.	8d.	..
j ,, 6 lea. Flax	per lb.	5¾d.	..
j ,, 3 ply 10 lbs. Russian	per lb.	4⅛d.	..
j ,, 10 lbs. Russian, single	per lb.	4¼d.	..
j ,, 180 lbs. Jute rove	per ton	£11	..
k Zinc, Sh't (Vieille Montagne bnd.)	per ton	£23 15	..

Quotations supplied by Messrs.:—*a* G. Boor & Co.; *b* The British Aluminium Co., Ltd.; *c* Thos. Bolton & Sons., Ltd.; *d* F. Wiggins & Sons.; *e* Frederick Smith & Co.; *f* India-Rubber, G.P. and Teleg. Works Co., Ltd.; *g* James & Shakspeare; *h* Edward Till & Co.; *i* Bolling & Lowe; *j* Walter H. Hindley and Co., Ltd.; *k* Morris Ashby, Ltd.; *m* W. T. Glover & Co., Ltd.; *n* P. Ormiston & Sons; *o* Johnson, Matthey & Co., Ltd.; *p* The Phosphor Bronze Co., Ltd.

ELECTRIC TRAMWAY AND RAILWAY TRAFFIC RECEIPTS.

	Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open.	*
	Aberdeen	Nov. 14	1,074	+239	30,633	+ 5,029	10	—
	Birmingham	,, 14	5,221	+119	234,357	+ 9,238	—	—
	Bournemouth	,, 4	894	—	—	—	10½	—
	Blackburn	—	—	—	—	—	12½	+1½
	Blackpool	,, 12	307	+ 2	35,934	— 209	8½	—
	Blackpool and Fleetwood	,, 14	222	+ 14	19,687	— 111	7½	—
	Blackpool and Lytham	,, 12	151	+ 77	292	+122	—	—
	Bolton	,, 15	1,6c6	+ 67	61,657	+ 7,525	25	—
	Bradford	—	—	—	—	—	41	+4
	Brighton	,, 16	824	+ 68	45,236	—	6½	—
	Bristol	,, 13	4,720	+419	—	—	28	—
	Burnley	,, 14	791	+103	—	—	7½	—
B.E.T. Co.	Barnsley District	,, 6	173	—	8,048	—	4½	—
B.E.T. Co.	Devonport	,, 6	540	+113	20,483	+ 1,100	5	—
B.E.T. Co.	Dudley—Stourbridge	,, 6	769	— 6	37,390	+ 5,595	18½	—
B.E.T. Co.	Gateshead	,, 6	949	+ 94	39,002	+ 5.180	10½	—
B.E.T. Co.	Gravesend—Northfleet	,, 6	235	+ 44	10,842	+ 1,088	3½	—
B.E.T. Co.	Greenock—Pt. Glasgow	,, 6	506	+ 11	24,493	+ 1,970	7½	—
B.E.T. Co.	Hartlepool	,, 6	262	+ 20	12,139	+ 727	6½	+2
B.E.T. Co.	Kidderminster	,, 6	104	— 3	5,787	+ 172	4½	—
B.E.T. Co.	Merthyr	,, 6	201	+ 28	8,876	— 117	3	—
B.E.T. Co.	Middleton	,, 6	269	+ 28	14,359	+ 1,767	8½	—
B.E.T. Co.	Oldham—Ashton	,, 6	537	— 7	25,463	+ 1,554	8	—
B.E.T. Co.	Peterborough	,, 6	119	—	6,626	—	—	—
B.E.T. Co.	Poole	,, 6	262	+ 16	13,722	+ 1,997	9½	—
B.E.T. Co.	Potteries	,, 6	1,692	+ 40	70,358	+ 8,707	28½	—
B.E.T. Co.	Rothesay	,, 6	48	+ 5	5,734	+ 1,607	2½	—
B.E.T. Co.	Sheerness	,, 4	63	—	2,706	—	2½	—
B.E.T. Co.	Southport	,, 6	250	+ 3	14,173	+ 2.588	6½	—

* Compared with the corresponding period of 1902.

	Locality.	Week ending	Receipts for the week. £	£*	Total to date. £	£*	Miles open.	*
B.E.T. Co.	South Staffordshire	Nov. 6	1,035	+308	40,557	+ 6,568	21½	−½
B.E.T. Co.	Swansea	,, 6	491	+ 53	23,214	+ 1,933	5½	—
B.E.T. Co.	Taunton	,, 6	56	+ 2	2,747	— 190	1½	+1½
B.E.T. Co.	Tynemouth	,, 6	283	— 8	14,241	+ 795	3½	—
B.E.T. Co.	Weston-super-Mare	,, 6	88	— 7	5,541	— 505	2½	+2½
B.E.T. Co.	Wolverhampton Dist.	,, 6	357	+ 17	17,451	+ 7,514	10½	+8
B.E.T. Co.	Wrexham	,, 6	113	—	4,463	—	—	—
B.E.T. Co.	Yorks. Woollen Dist.	,, 6	567	—	14,323	—	6	—
	Cardiff	,, 14	1 865	+332	66,896	+18,430	14	—
	Chatham & District Co.	,, 5	545	+159	24,013	+13,172	8·53	—
	Dover	,, 14	165	— 7	10,236	+ 51	3	—
	Dublin	,, 13	4,502	+200	104,653	+ 7,723	46½	+ ½
	East Ham	,, 14	612	+160	22,685	+ 7,094	5	+ ½
	Glasgow	,, 14	13,734	+1051	329,766	+35,063	66	+1½
	Hull	,, 14	1,895	+183	62,007	+ 3.363	11½	+1½
	Ilkeston	,, 11	106	—	—	—	4	—
	Isle of Thanet	,, 14	283	— 47	31,776	— 1,648	10½	—
	Leeds	,, 14	5,105	+250	185,193	+11,079	41	—
	Liverpool	,, 7	9,900	— 2	454,247	+14,525	103	—
	Manchester	,, 14	14,315	+6165	889,622	+235,295	72	—
	Newcastle	,, 14	3,570	+488	—	—	17	—
	Portsmouth	,, 7	1,531	+249	—	—	14½	—
	Salford	—	—	—	—	—	30	—
	Southampton	,, 12	906	— 22	—	—	9	—
	Sunderland	,, 15	1,035	— 27	41,726	+ 2,007	20	+3
	Central London Railway	,, 14	6,996	—362	124,921	— 6,624	6	—
	City and S. London Ry.	,, 15	2,894	— 535	51,661	— 8,197	6½	—
	Dublin and Lucan Rlwy.	,, 15	101	+ 10	2,679	+ 165	6½	—
	Liverpool Overhead Ry.	,, 15	1,636	+ 84	33,594	+ 2,209	6	—

PRACTICAL EXAMPLES WITH THE CALCULATOR BOARD.

By EDWARD RAYMOND-BARKER.

Series I.—*Notes for Submarine Cable Staffs.*

(*Concluded from page* 761.)

To take in detail that for November 14th (fig. 27) let omnibus scale g_3 be abscissa.

Let 0 (zero) be taken as any convenient value not higher than the likely resistance to break already suggested by

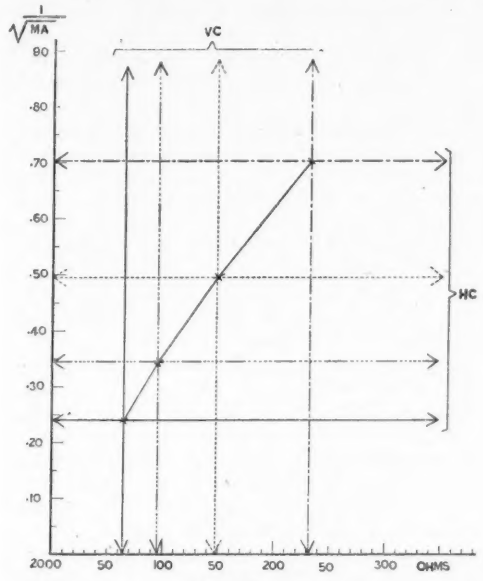


Fig. 27.

preliminary bridge tests—say, in the present instance, 2,000 ohms. Thus the inferred zero of the horizontal line of resistance is 2,000 ohms distant to the left of the actual scale zero on the curve sheet, which we can therefore mark in pencil on the overlying celluloid working surface: 2,000 ohms. Then—

100	on abscissa scale	g_3	= 2,100
200	"	"	= 2,200
300	"	"	= 2,300
400	"	"	= 2,400

and so on, millimetres, for the nonce, representing ohms.

So much for the abscissæ. Now for the ordinates.

Scale G_1 is graduated in terms of $\frac{1}{\sqrt{\text{ma.}}}$ from 0·02 up to 0·92.

To proceed with plotting, from above data, a Jona localisation curve, on the celluloid overlying the curve sheet, taking the test for November 14th as an example :—Scale zero (S Z.).

Firstly :—Bring H.C. to 0·240 on scale G_1 (ordinate).

Secondly :—Bring V.C. to 2,064·5$^{\omega}$ on *omnibus* scale g_3 (abscissa).

0 (zero) of this scale having been taken as 2,000$^{\omega}$, V.C. is brought, in point of fact, to 64·5, which thus becomes the extremity of the resistance horizontal of 2,064·5$^{\omega}$ ohms.

Care must be taken that H.C. and V.C. have truly rectangular intersection; in other words, that H.C. and V.C. are truly parallel respectively to ordinate and abscissa scales.

This rectangular intersection is easily and quickly verified by means of cross-lines on the curve sheet, and by correspondence of millimetre readings at extremities of H.C. and V.C.

H.C. having been brought to 0·240 on G_1, V.C. having been brought to 64·5 (= 2,064·5) on g_3, a tiny pencil cross or other mark is made on the celluloid working sheet at the point where H.C. and V.C. intersect each other. It is, of course, optional which edge of each cursor strip is used for scale readings, as long as the two edges used truly intersect at right angles.

A similar operation is effected for 0·345 on G_1, and 95·5 (= 2,095·5) on g_3, H.C. being brought to the former and V.C. to the latter. A second cross (x) is then plotted at point of intersection, H.C. with V.C.

H.C. is then moved up to 0·494 on G_1, and V.C. along to 148 (= 2,148) on g_3, a third cross being made at point of intersection.

Lastly, H.C. is moved to 0·703 on G_1, and V.C. to 232 (= 2,232), and a fourth cross is plotted at point of intersection, H.C. with V.C.

The four plottings thus made may now be inter-connected by straight lines, the entire line so constituted forming one curve, the lower extremity of which is directed, comet-wise, towards that point on the graduated horizontal resistance line which gives the true ohmic resistance extending between testing station and broken end.

In the present instance the curve for November 14th, the plotting of which has just been effected, as shown in detail in fig. 26, is clearly directed towards—or very close to—0 (zero) on the scale to the left of which, as has been shown, extends an imaginary or inferred scale of 2,000 ohms.

Once the curve in question has been drawn on the celluloid working surface, a tracing may be made of it from the celluloid on tracing paper, in which case only that portion of the horizontal scale of resistance need be drawn which is in immediate proximity to (0 =) 2,000 ohms which, in this case, is the resistance up to the broken cable end.

Or the remainder of the horizontal scale representing resistance may be utilised for the accommodation of further curves, the same system of inferred scale zero being followed as in the first instance.

For example, if it be found convenient to retain the November 14th localisation curve on the celluloid working surface, for the plotting of the curve for November 19th, 100 on scale g_3 may be taken as 2,000, in which case—

200	on scale g_3	becomes	2,100
300	"	"	2.200
400	"	"	2,300

and so on, the necessary temporary alterations of the scale numeration, in the various cases, being easily made, in pencil, for the purposes of the required curves.

This is one inestimable convenience of the matt surface celluloid, namely, that it permits of pencil work, and marks, and notes of all kinds being made against any of the

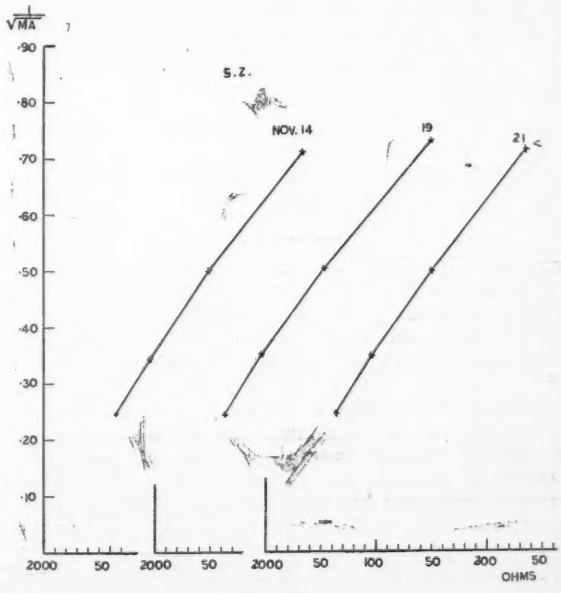


Fig. 28.

scales. Or a totally new scale may be graduated to serve any purpose not taken into account in the design of the present curve sheet.

Fig. 28 shows curves for bridge tests to scale zero, given in the table already referred to. These curves were afterwards transferred to tracing paper to be added to other permanent records.

Fig. 29 shows corresponding tests to false zero or cable

zero (C.Z.) for the same dates as those already mentioned. These tests to false or cable zero have been plotted out in a manner exactly similar to that already described in the case of the scale zero tests.

There is no need to give the figures, which were obtained in a similar manner to those given in the foregoing tables, except that all bridge readings were to false, or cable zero.

Another great use of the calculator-board, as one of the appurtenances of a submarine telegraph station, now

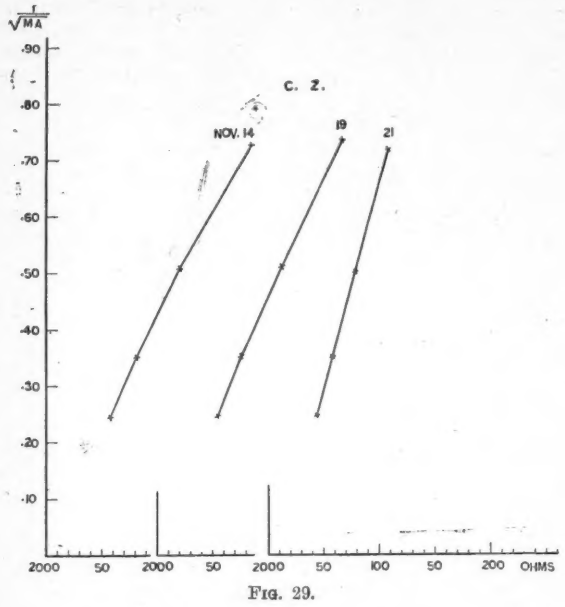


Fig. 29.

becomes clearly apparent, seeing the remarkable manner in which the board lends itself to the rapid compilation of localisation records—records so graphic that the eye seizes instantly upon any change in the characteristics noticeable in the curves recorded—if necessary—from day to day. Tracings, or blue prints of the said curves may be enclosed with reports to headquarters, whilst other copies might be communicated to the cable ship.

Obviously the usual calculations, by any of the various methods, may be made on the basis of the same data employed for the obtaining of the curves.

(*Conclusion of Series I.*)

ELECTRONS AND ATMOSPHERIC ELECTRICITY.

One result of the development of the new theory of electrons is likely to be a great addition to our knowledge of the causes and phenomena of atmospheric electricity.

Elster and Geitel have made numerous experiments to ascertain the rate at which an electroscope loses its charge in different localities and in different states of the weather. They found that the rate of leak was greater at high altitudes than at low ones, and that on the tops of mountains negative electricity escaped faster than positive. The latter phenomenon is evidently due to the fact that the negative charge of the earth accumulates at the mountain peaks and repels with greater intensity the negative charge of the electroscope. The experiments made in different states of the weather showed that the rate of leak was much smaller in mist and fog than when the weather was bright and clear.

Investigations into the nature of electric conductivity in gases, have shown that electricity can only pass through a gas when it is carried by means of free positive or negative ions or carriers. The positive ions are usually uncombined atoms or positive electrons, and the negative ions are the so-called negative electrons, or corpuscles, whose mass is only about one-thousandth part of the mass of an atom of hydrogen, though their negative charge is equal in quantity to the positive charge of the positive electron. One consequence of this is that under the influence of an equal electric force the negative electron moves much faster than the positive electron.

The rate at which a charged electroscope loses its charge, is thus a measure of the percentage of free electrons in the atmosphere. Another method of measuring the percentage of free electrons in the atmosphere has been devised by Prof. Ebert, of Munich. In his apparatus an aspirator driven by clockwork draws a definite quantity of air through the annular space between two coaxial cylinders; the inner cylinder resting directly on an electroscope, while the outer is connected to earth. If the capacity of the system, and the quantity of air drawn through it in a given time is known, then one can (from the number of volts indicating the loss of potential during the time) calculate in absolute measure the quantity of electricity contained in a cubic metre of air, and from that deduce its charge of free electrons.

Determinations made with this apparatus in Switzerland showed that the charges of electrons found at the surface of the earth depended on changes going on in the higher strata of the atmosphere. Thus, during the Föhn (a violent south wind), the charge of electrons was not only absolutely very high, but the normal preponderance of negative electrons was changed to a decided preponderance of positive electrons. Experiments in balloons have shown that the charge of electrons in the atmosphere increases rapidly with the altitude. There is consequently a higher degree of conductivity of the air about mountain peaks, and as the negative charge of the earth accumulates at these peaks, both the mobility of the negative electrons and the force acting upon them are great. The negative electrons are consequently driven away, and a great excess of positive electrons is left in the air surrounding mountain peaks. When the south wind blows over the mountain crests, the air, charged with positive electrons, is driven down into the valleys.

This changing of the electronic content of the atmosphere appears to have a specific effect on the human organism. Czermak, who has studied this phenomenon in the Föhn region at Innsbruck, is disposed to connect the increase in the density of positive electrons with the so-called Föhn sickness which attacks sensitive persons, and for which, up to this time, no satisfactory explanation has been found. In this connection, the results of the Monte Rosa expedition, for the investigation of mountain sickness, recently reported on by Caspari, are very interesting. It was found that the electronic content attained a very high figure in hollows, caves, and chasms which communicate with the open air, but at the same time retain a considerable quantity of quiet, stagnant air. Now, according to the experience of mountain guides, it is in such partially enclosed spaces that the complex phenomena of mountain sickness are most apt to occur, even where altitude offers no predisposing cause for this effect. In a passage on Monte Rosa, notorious for its mountain sickness, Caspari found with the Elster-Geitel apparatus an enormously large charge of electrons.

The normal distribution of positive and negative electrons at different altitudes may be greatly disturbed by vertical air currents, such as are produced when the surface of the earth is greatly heated by the sun in the summer time. The ultra-violet element in sunlight causes the earth to freely discharge negative electrons into the stratum of air in contact with the earth's surface, and this when heated carries its charge of electrons to considerable heights. Recently it has been discovered that a peculiar stratification exists in the air which so sub-divides the whole column of air above us that the temperature and amount of aqueous vapour suddenly change their value in passing from one stratum to another. These stratifications are of the greatest importance for the formation of clouds. Now it is noteworthy that with each entrance into a new stratum there has been observed a sudden change in the electronic charge, and also in the proportion in which the positive and negative charges are mixed in these strata. Therefore, just as each stratum is characterised by a certain temperature and moisture, so it is also characterised by certain electrical properties which seem to be conditioned chiefly by its origin.

In the stratum of cumulus clouds about 2,000 metres above sea level, Ebert repeatedly found charges of electrons more than four times as great as those on the earth's surface.

At the earth's surface, under normal conditions, there is a charge of one to three electrostatic units per cubic metre of free electronic electricity, there being a slight excess of the positive charge over the negative. With increasing altitude the positive and negative electronic charges become more nearly equal, but the total number of free electrons increases. At an altitude of 3 kilometres there is a total charge of more than four electrostatic units per cubic metre. Conrad (*Wien. Ber.* III. *Ab.* II. *a* p. 342, 1900) has estimated from Elster and Geitel's determinations that the amount of electricity in 1 gram of the water of a cumulus cloud amounts to $\frac{1}{3}\frac{1}{6}$ of 10^{-8} of a coulomb. Within a dense cloud there was, according to Conrad's measurements, 5 grams of water per cubic metre. There was consequently an electric charge per cubic metre of the cloud of about $\frac{1}{7}$ of 10^{-8} of a coulomb. This approximates very closely to the charge of four electrostatic units, *i.e.*, $\frac{4}{3}\frac{1}{0}$ of 10^{-8} coulomb found by Ebert to be the free electronic charge in the air at a height of 3 kilometres, and the electronic charge appears to have been entirely absorbed by the moisture of the cloud.

The explanation of this phenomenon is to be found in the experiments of C. T. R. Wilson, who found that in slightly supersaturated air free from dust, electrons acted as nuclei for the condensation of moisture. When the supersaturation reaches a certain limit, the particles of moisture form first round the negative electrons. If the supersaturation is still further increased, the particles of moisture are formed round the positive electrons. If the air is not free from dust, the particles of dust act as nuclei for particles of moisture before the negative electrons. Thus, if a stratum of air contains dust particles and both positive and negative electrons, the first result of a gradually-increasing supersaturation is a condensation of moisture about the particles of dust. If this moisture falls as rain, the rain will be electrically neutral. The second condensation takes place round the negative electrons, and this may result in a shower of rain with a negative electric charge. The third condensation, if the supersaturation goes far enough, will be about the positive electrons, and the shower of rain which may result will be positively electrified. The neutral, negative, and positive showers of rain following each other in succession have been observed by Elster and Geitel. The particles of moisture formed may not be large enough to fall as rain, and the process described above may only lead to the formation of positively and negatively charged clouds separated from each other by a greater or less distance. This condition is evidently favourable to a discharge of lightning between the two clouds. If a negatively charged cloud approaches sufficiently near to the earth's surface, a discharge of lightning takes place between the cloud and the earth. This discharged cloud being now at the earth's potential will discharge clouds behind, and the thunderstorm may in this way gradually spread over an extensive region. Conrad has shown that the potential difference created by a charged cloud is quite sufficient to cause lightning discharges over great distances. If, for instance, we suppose a cumulus cloud of spherical form of only 1 km. radius to rest with its centre 3 km. from the earth's surface, then it will by its own internal charge cause a decrease of potential at the earth's surface of 11,000 volts per metre of vertical distance. Such values have actually been observed in thunderstorms at the earth's surface. For such a gradient a point in the air 500 metres above the earth would show a difference of potential of $5\frac{1}{2}$ million volts with respect to the earth's surface, and such pressures are quite adequate to bring about a discharge of lightning.

Thus the theory of electrons appears to give a more satisfactory explanation of the origin of atmospheric electricity than any of the numerous hypotheses that have already been proposed. There may be more than one cause at work bringing about the dissociation of the neutral molecule into its positive and negative elements. The ultra-violet constituent of sunlight is known to be an effective cause. Another cause has been suggested by Schuster, namely, the presence of radio-active substances in the earth. The particles projected from radio-active substances are known to be powerful ionisers of air. There has been a growing tendency of late to believe that the sun emits cathode rays or negative electrons, which penetrate the upper strata of our atmosphere. It has also been suggested that the heat of the sun is due to the presence in its mass of radium in high percentage. Both cathode rays and the emissions from radium are powerful ionisers, and they may, therefore, contribute largely to the production of free electrons in our atmosphere.

The free negative electrons, as has been stated above, are more mobile, on account of their smaller mass, than positive electrons. A consequence of this is that, when near a conductor like the earth, they are attracted by induction and absorbed in greater quantity than the positive electrons. But this attraction of the negative electrons will only take place to any extent in hollow parts of the earth's surface, such as chasms and caves, because in these the repulsive force of the negative charge of the earth is neutralised. On mountain peaks, on the contrary, the repulsive force of the earth's negative charge is exaggerated and free negative electrons are driven off into the upper air.

The result of these opposite actions on the negative electrons is to leave an excess of positive electrons in the atmosphere near the earth's surface, both in deep valleys and on mountain peaks. There is no doubt an intermediate curvature of the ground where the percentage of the two kinds of electrons in the air remains practically equal.

The theory of electrons has placed a new instrument in the hands of the meteorologist to unlock the mysteries of the weather, and no observatory in future will be complete without its electronometer.

THE BRITISH ASSOCIATION, SOUTHPORT, 1903.

THE RESISTANCE OF ROAD VEHICLES TO TRACTION.

Report of the Committee consisting of Sir J. I. Thornycroft (*Chairman*), Prof. H. S. Hele-Shaw (*Secretary*), Mr. T. Aitken, Mr. T. C. Aveling (*Treasurer*), Prof. T. Hudson Beare, Mr. W. Worby Beaumont, Mr. J. Brown, Col. R. E. B. Crompton, Mr. B. J. Diplock, Mr. A. Mallock, Prof. J. Perry, Sir D. Salomons, Mr. A. R. Sennett, *and* Mr. E. Shrapnell Smith. (*Drawn up, at the request of the Committee, by the Secretary, assisted by* Mr. J. F. Gill, *B.Sc.*)

I.—*Results of Trials made with Committee's Dynamometer.*

In the last report the new dynamometer made for the Committee was described and illustrated, together with an account of the calibration of the apparatus.

It will have been noticed in the drawing of the instrument that a small screw-down valve was fixed in the circuit of the tube which transmits the pressure from the plunger to the recording gauge, this valve being for the purpose of throttling the flow of water, and thus damping the oscillations of the pencil. The principal dimensions of the valve are as follows:—

Width of seat	·008 in.
Smallest diameter of seat	·1595 „
Largest „ „	·1693 „
Pitch of screw	·046 „

It was found that to produce sufficient damping action it was necessary to have this valve off its seat by an amount of not more than ·0153 in.

It was pointed out by Mr. A. Mallock, F.R.S., of London (a member of this Committee), that the flow under a constant pressure of a fluid through a thin film-like orifice such as this, might be different in one direction to what it would be when flowing in the reverse direction, owing to the stream-line formation not being symmetrical about the constriction.

If such were the case, the true mean pressure would not be recorded, but some pressure, either greater or less than the true mean, according to which side of the valve was next to the plunger.

Experiments were made to determine the minimum orifice that might be used, and it was found that equal flow from either side did not occur until the valve was opened by at least half a turn, this corresponding to the valve being raised from its seat a distance of ·023 in. So that there should be no doubt about the orifice being too small, the experiments were conducted with the valve open by a considerable amount, the damping action being obtained by squeezing the rubber tube which connected the gauge to the dynamometer by suitable clips placed on the tube some distance from any change in cross-section. By this means the stream-line flow was kept perfectly symmetrical about the constriction, and hence the true mean pressure was recorded.

Mr. Mallock has suggested the adoption of a length of resistance tubing (say $\frac{1}{3}\frac{1}{0}$-in. bore) to attain the same end, and this will be fitted for subsequent trials.

Experiments.

The first experiments conducted with this dynamometer were mentioned in the last report, and the results were indicated by means of wall diagrams. The results then obtained have been carefully gone into, and from them the following curves have been plotted.

Experiments with Iron Tires.

These experiments were conducted on a portion of Regent Road, Bootle, which is paved with setts 6 in. × 3 in., having a regular, but fairly rough surface, with a 1-in. gap between the joints. Regent Road runs along the line of docks, and is, in consequence, free from

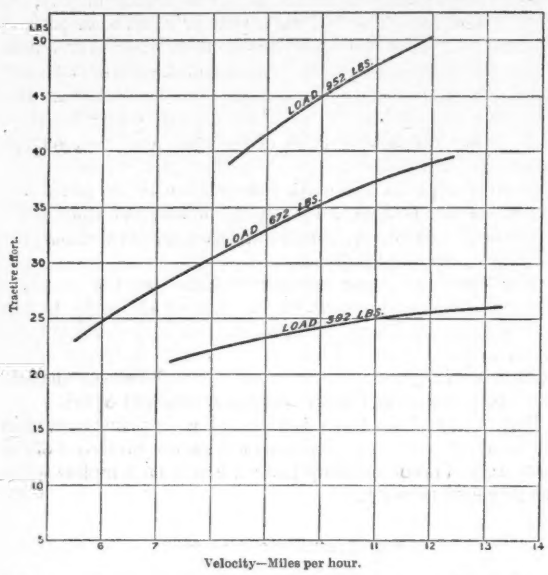


Fig. 1.—Tractive-effort Velocity Curves for 40 in. Iron Tire on Setts.

gradients; it is, however, so crowded with vehicles during the daytime that it was found necessary to conduct this series of experiments during the night.

The wheel used is a light lurry wheel, 40 in. diameter, having a 3-in. iron tire slightly rounded in section.

The axle was tilted up out of the horizontal at one end, so that the wheel, which was slightly coned, could take up a position exactly similar to the lurry wheels in general use; it was mounted on a pair of springs 3 ft. 2 in. between the centres of attachment, each spring comprising six plates 2¼ in. × $\frac{5}{16}$ in.

Three runs were made over this particular route with loads of 392, 672 and 952 lbs. respectively, at speeds of from 5 to 14 miles per hour.

The results of these trials are plotted in fig. 1, with total tractive effort (inclusive of axle friction, &c., as ordinates, and velocity as abscissæ.

It will be noticed that for each curve the tractive effort increases with the velocity, but these curves and all subsequently obtained are

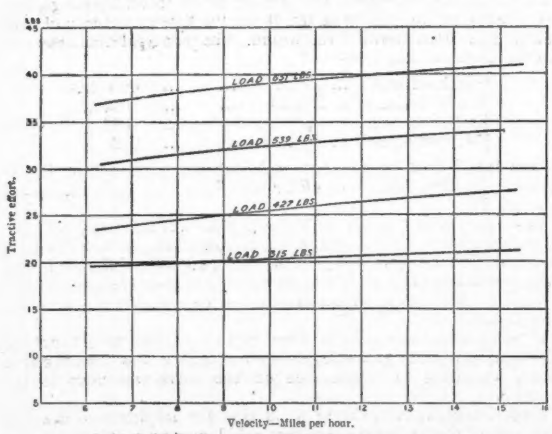


Fig. 2.—Tractive-effort Velocity Curves for 24 in. × 2¾ in. Pneumatic Tire on Macadam.

concave downwards, showing that the rate of increase of tractive effort diminishes with the velocity. This may be due to the fact that as the wheel travels faster it has less time to fall into the little hollows in the roadways, merely skimming along the tops of the ridges.

Well-laid setts under these circumstances, even with wide deep gaps, form a perfectly smooth track at high speeds. This is well brought out in fig. 4, which shows a smaller tractive effort for setts than for macadam.

On looking into the matter, this is as it should be Consider two perfectly level roads, one made with setts and the other with macadam: the setts present a surface which is extremely hard, although irregular, but this irregularity with well-laid setts is more apparent than real, as the tops of the setts themselves are smooth and level and all in the same plane.

The macadam, on the other hand, although quite level, is not nearly so hard as the stone surface, and is, moreover, covered with a thin layer of dust or fine gravel, which, as is well known, retards the progress of a vehicle.

Experiments with Pneumatic Tires.

A series of experiments were made with a pneumatic-tired wheel 24 in. diameter, 2¾-in. tire. This was a wire-spoked wheel of the

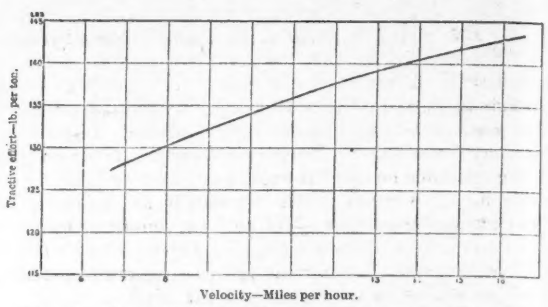


Fig. 3.—Curve Showing Tractive Effort per Ton for Pneumatic Tire 24 in. × 2¾ in. on Macadam.

type used on light voiturettes; it was mounted on the same springs as the lurry-wheel mentioned previously, but they were reduced in strength by the removal of four plates, so that each spring consisted of two plates 3 ft. 2 in. long, 2¼ in. wide, and $\frac{5}{16}$ in. thick.

This series of experiments was conducted on a level stretch of macadam road, the surface of which was in fairly good condition, slightly wet in places; runs were made with loads of 315, 427, 539, and 651 lbs. respectively.

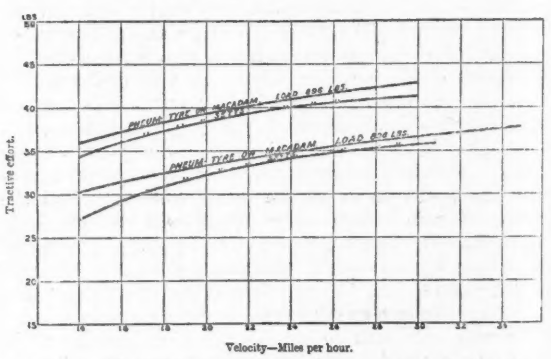
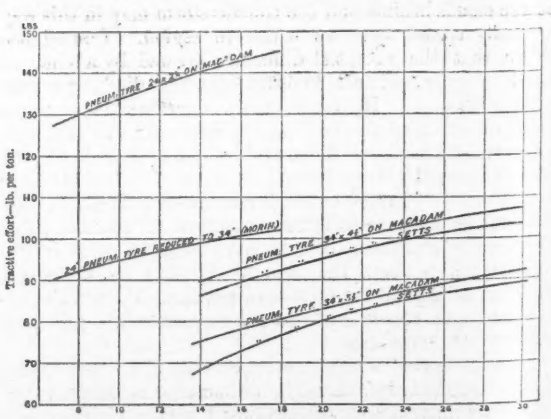


Fig. 4.—Tractive-effort Curves for 34-in. Pneumatic Tires on New Macadam.

Fig. 2 shows tractive effort and velocity plotted for each of these loads. It will be noticed that the ratio of tractive effort to load for these curves is very nearly constant, and that the tractive effort increases slightly with the velocity. Sufficient results have not yet



(Note.—The macadam on which the 24-in. wheel was run was older than that on which the 34-in. wheels were tried.)

Fig. 5.—Curves Showing Tractive Efforts per Ton for Pneumatic Tires.

been obtained to enable this committee to state definitely the law relating to tractive effort and load, but the results of the experiments that have been made agree with those obtained by such pioneers in this research as General Morin, M. Dupuit, M. Michelin, and others. Assuming for the time that the tractive effort is directly proportional to the load, a curve has been plotted between

tractive effort per ton and velocity (fig. 3) which is useful for comparison with similar curves for wheels of different diameters.

Additional experiments were made on pneumatic tires under the auspices of the Automobile Club of Great Britain and Ireland. For these trials it was found that the car used by the Committee was not of sufficient power; a 24-H.P. Panhard & Levassor car was therefore temporarily used.

It will be noticed in the photograph of this later car (fig. 6, Plate I) that the springs supporting the experimental wheel have been placed above the frame, thus enabling the centre of gravity of the trailer to be brought very near to the ground. This alteration was found necessary owing to a sidelong oscillation taking place at high velocities when the frame was in the position as first arranged. The altered position proved quite successful, not the slightest oscillation of the trailer being noticed even when heavily loaded and travelling at 35 miles per hour, which, it must be admitted, is a fairly high speed at which to tow a wheel loaded with a weight of 900 lbs.

Some difficulty was at first experienced in getting this car to pull steadily at lower speeds, as the governor was constantly coming into action owing to the full power not being required. This was finally overcome by completely cutting out two of the cylinders, and thus reducing the power of the car by half.

These experiments were made with two sizes of tires, one 34 in. diameter × 3½ in., and the other 34 in. diameter with a mean diameter of cross-section of 4½ in.

Runs were made at speeds of from 12 miles to 35 miles per hour, over both good macadam, frozen hard, and good dry setts. The springs supporting the trailer were 3 ft. 2 in. long, each having four plates 2¾ in. × $\frac{5}{16}$ in., and the tires were in all cases pumped to a pressure of 60 lbs. per sq. in., the total load on the wheel being 896 lbs. The results obtained and plotted in fig. 4 show that the tractive effort under similar conditions as to road surface and speed is less for the tire of smaller cross-section than it is for that having the larger section. This may be due to the fact that the tread of the larger tire was much thicker than the smaller, rendering it in consequence more after the nature of a solid tire, it being well understood that a perfect pneumatic tire should have as little inelastic, or comparatively inelastic, material about it as possible; or, the greater tractive effort may have been due to the greater cross-section. Repeated experiments alone can definitely settle this question.

Fig. 5 shows these curves plotted as tractive effort per ton. On the same axes the tractive effort per ton has been plotted for the previous wheel (pneumatic tire 24 in. × 2¾ in.), and it is very much greater than that for the 34-in. wheels.

This Committee is not yet in a position to state the exact relation between traction effort and diameter of wheel; but, taking the results of General Morin, that the draught is inversely proportional to the diameter of the wheel, a curve has been plotted (fig. 5) which reduces the tractive effort of the 24-in. wheel to that of an equivalent 34-in. wheel. Considering the variations that may have existed in the roads on which the wheels were tried, as it was at different times of the year, these results harmonise fairly well.

(To be continued.)

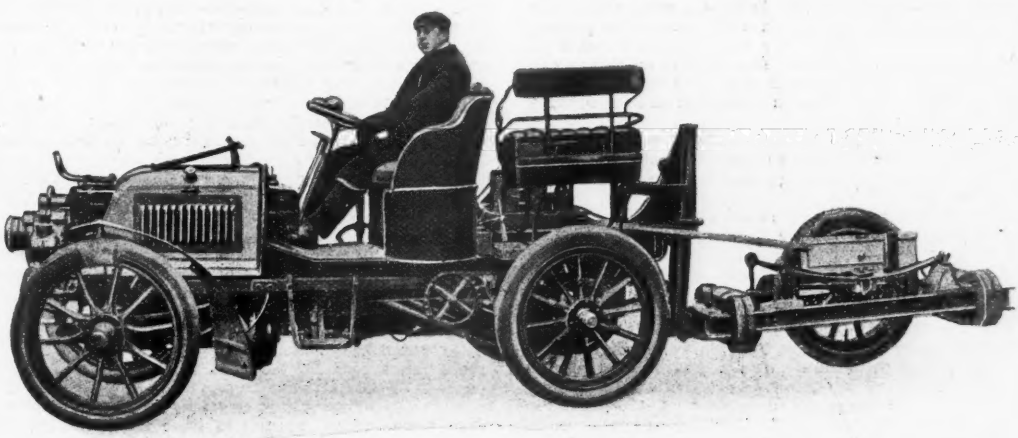


Fig. 6.—24-H.P. Panhard Levassor Car Fitted with Dynamometer and Trailer.

INSTITUTION OF ELECTRICAL ENGINEERS.

Inaugural Address by Robert Kaye Gray, President.

(Delivered on Thursday, November 12th, 1903.)

Gentlemen, another session has opened, and another President addresses you, the twenty-eighth person who has had this privilege. On this occasion one of our usual forms of procedure must be dispensed with, or I should have to fill the *rôle* of vacating the chair in my own favour. You will remember that Mr. Swinburne, who gave us an extremely interesting and valuable address a year ago, resigned the Presidentship two months before his term was completed. This he did in order to permit a telegraph man to be at the head of the Institution during the recent International Conference in London, to which telegraph delegates from foreign Governments were invited.

For obvious reasons, I cannot criticise Mr. Swinburne's action in this matter, but I feel at full liberty to say that the manner in which he carried out what he thought to be the best interests of the Institution was accomplished with great consideration, and for this, so far as it affected me personally, I tender him my sincerest thanks.

You, gentlemen, have placed me in the honourable position which I now fill, but the honour which you have conferred is one that carries with it a responsibility which might better have been confided to other hands.

The Institution is ever growing, and shows the life that dwells in every healthy, hardy plant which from a seedling becomes a well-grown tree. Not one of the founders of the Institution in 1871 could have foreseen the developments of a third of a century later. The guidance of your former Presidents and Councils have been wise, and it is for us to follow in their footsteps with the same open minds which have led to the consolidation of many diverging interests into one complete whole. We are under a debt of gratitude to the Institution of Civil Engineers for many advantages they have conferred on us, and not the least is the cordial hospitality they give us in their magnificent building. Your successive Councils have continually had brought to their notice the desirability of our Institution possessing a permanent habitation, and it is believed this feeling is general among the members. I take this opportunity of stating that, in deference to this view, a site has been acquired, which, in the opinion of the Council's technical advisers, will amply suffice for the erection of an Institution building in which a suitable lecture theatre and other necessary offices could find place. Your Council has no intention of proceeding with the construction of the Institution building until they believe the Institution to be strong enough financially to meet the necessary expenditure while remaining in possession of a handsome surplus. It is also thought that developments in the near future may permit of an alliance with kindred institutions for the erection of one large Temple of Engineering, where the various branches may find their homes. A portion of this building could be allotted to the joint occupation of the various sections of engineering, and each section could in addition possess the accommodation it might require for its own particular work, a Senate or Court of Governors appointed by the sections being constituted the supreme body. I understand that the late Sir William Siemens had such a conception, and perhaps its realisation may now be within the range of practical politics. In the event of such a scheme maturing, the property in Tothill Street, which the Institution has acquired, can be sold, as it will always be a realisable asset so long as no special building is erected on it. A Temple of Engineering costing a quarter of a million would be a fit home for the engineering bodies of this country.

Many opinions have been advanced as to the scope and aim of an Institution such as ours; as to what it should do and what it should not do, and as to its relations with kindred societies. This, of course, is contentious matter, and should not probably be touched in an address, but I take advantage of the immunity from criticism in this room which my position to-day grants me, and will make a few remarks on the subject. In early days the Institution was the only Association or body which could voice the views of electrical men, and therefore everything touching their interests was fit matter for discussion. To-day the necessity is not so imperative, as, owing to the great development of the electrical industry, other bodies are springing up who can more properly deal with a variety of questions which affect, but only indirectly affect the institution as an Institution of Electrical Engineers. As time goes on, this necessity will become less and less, and the Institution will fall back into its proper function as an Institution of Electrical Engineers, and will not fill the part of an Association of Electrical Engineers, which it has often been obliged to do in the past. The word "Institution" in this connection bears in my mind the meaning of a body for

dealing with technical interests, while "Association" implies a corporation whose functions are related to everything affecting general interests. I hope that the Institution, for some time yet, will continue to take an interest in things general as well as technical, and conserving the open mind and progressive spirit, to which I referred in my preceding remarks, will assist in every reasonable way the aspirations of the different electrical associations which are being formed from day to day. These associations must not be looked upon as rival or interfering bodies, but rather as bodies formed to meet a real want, and from that point of view deserving every assistance and encouragement from the older body. There is one more point in this connection which from time to time provokes comment and criticism, and that is that many members of this Institution contribute papers to the Institution of Civil Engineers and other bodies which, in the opinion of the critics, should have been presented to this Institution. I do not think this is a fair or a wise criticism. People, readers of papers or others, will always carry their wares to the best market, and the only effective way of dealing with the situation is for the members and officers of this Institution to strive to make our market the best. Those who read papers on electrical subjects in other institutions are in reality doing a great good to the electrical industry and to this Institution, as they play the part of the missionary who goes out into the wilds, spreads the light and eventually gathers converts into the fold. I therefore say that our members who read papers before other institutions or societies are well-doers, and should not be submitted to the unfair criticism which emanates from a spirit akin to some of the elements of trade unionism, and is much to be deprecated. While admitting the desirability of the existence of these electrical missionaries, I also urge that the members and officers of the Institution should leave no stone unturned in their search for what is good and useful to the Institution. Our predecessors have done this, and the task of the present Council and members should be much easier than the task which their forerunners have performed. What they accomplished is made clear by a reference to our membership. An Institution, which in 1871 numbered 80 persons, and to-day numbers 4,800, has every reason to be proud of its development and growth. It is my belief that the Institution will continue to develop, and if it is governed in a tolerant and broad-minded spirit will never cease to be the referee in all cases affecting electrical science and industry.

I now propose to lay before you some matter I have had collected relating to the effect that existing legislation has had on electrical enterprise, and containing a few suggestions for the betterment of the present situation.

As the generation and supply of electricity for lighting, power, or traction are strictly regulated by Act of Parliament, it is obvious that electrical progress must be seriously affected for good or for evil by the state of the law relating to electricity. It is impossible to attempt here to cover the whole field of electrical legislation, but attention may be directed to one or two special points.

If we omit the Electric Lighting (Clauses) Act of 1899, which merely codifies the provisions usually incorporated in a provisional order granted by the Board of Trade, we find that there has been no public legislation upon the generation and distribution of electricity since 1888, when an Act was passed to amend certain defects in the original Act of 1882. This absence of legislation during a period in which the applications of electricity to the service of mankind have been enormously improved and extended, would not be remarkable if the original Acts had been adequate not only to the needs of the time at which they were passed, but to those of the present day; but, as everyone knows, this is far from being the case. Those Statutes were framed to meet the case of distribution of electricity over a small area, and no provision was made for the time, which has long since arrived, when it would be possible and even economical to distribute from a given centre over a wide area, extending far beyond the boundaries of any particular parish or municipality. There might still have been a chance that the parochial idea embodied in these early Statutes would in the course of time have been abandoned, had not Parliament fixed this idea as a permanent feature of British electrical distribution by giving to the local authorities the right of purchase of the undertakings supplying their areas after a period which was first stated at twenty-one years, but afterwards extended by the Act of 1888 to forty-two years. In addition to this, the Act of 1888, although intended to promote the introduction of electric lighting, went far towards stifling private enterprise in this direction, by giving to the local authorities a veto on any petition to supply electricity within their areas. Thus it has come to pass that in spite of the great progress made since 1888 in the science of distribution, no one but a local authority can to-day obtain free unimpeded access to the Board of Trade with a petition for a provisional order, and as local authorities are as jealous of one another as they are of private companies, the general result is that the municipal area is still the unit area for distribution.

There are, of course, many other prominent defects in the Electric Lighting Acts. They do not, for example, provide for the compulsory purchase and sale of sites for generating stations, nor yet for the erection of these stations outside the area of supply. If promoters of an undertaking desire either of these things they must proceed by Special Act, not by Provisional Order; and the best proof of the inadequacy of the Electric Lighting Acts to modern needs is that these Private Acts usually contain special clauses of which the object is to render inapplicable a larger or smaller number of the sections of the controlling public Statutes. The whole subject was considered in 1898 by Lord Cross's Committee, which made many recommendations of the highest value—among them, the abolition of the veto and the removal of the defects just noticed; but until the present year the Government has shown no sign of being desirous or willing to give these recommendations the force of law. The Institution of Electrical Engineers, which has always been alive to the serious consequences of this defective legislation, sought in June of last year to bring pressure upon the Government, by sending a deputation to the President of the Board of Trade. It is impossible to express more forcibly or more clearly the objections to the present law than was done by the members of our deputation on that occasion; but although we were then promised a measure to remove these objections, nothing was attempted until May of this year, when a Bill, embodying most of the recommendations of Lord Cross's Committee, was introduced in the House of Lords by Lord Wolverton at the instance of the Board of Trade. But the Bill did not get beyond the introductory stage, and at the close of the session no progress had been made. The measure, however, must not be allowed to drop; and as the President of the Board of Trade has told us that his department desired to "press forward" this measure when opportunity offered, we may express the hope that next session it may not only be introduced, but may be placed upon the Statute-book.

With regard to the distribution of electricity for power purposes, the Electric Lighting Acts make no special provision. Any consumer may use his supply either for lighting or power, or both. But in recent years the idea of promoting large power schemes to supply very wide areas has come prominently to the front, and since 1900 several such schemes have been authorised by special Acts of Parliament. The powers of supply conferred upon companies under these Acts are twofold; they may supply energy for power purposes to any person, and they may supply energy in bulk to authorised distributors. In this connection it may be noted that if the Bill introduced by Lord Wolverton becomes law, it will be possible to obtain powers for supply in bulk to authorised distributors by provisional order instead of proceeding, as at present, by special Act. The most important point, however, about these modern power schemes is that, in many cases, the promoters come into sharp conflict with local authorities and other authorised distributors supplying urban or rural districts within the large area which they desire to cover by their scheme. The local authorities are especially antagonistic to any proposal which would allow any other body to come into their area to supply electricity, and in some cases Parliament has cut out, from the area which a particular scheme desires to cover, various towns and districts possessing their own electricity supply undertakings. Now it seems desirable that the local authorities should consider carefully the advantages of taking their supply in bulk from a power scheme, instead of generating for themselves on a small scale. In very many cases it would be much more economical to do so, and they would still be left the sole distributors in their own areas. But if local authorities will not do this, Parliament must consider what is best for the country at large; and as the rural districts must obviously gain by the supply of electrical energy at cheap rates, the towns should not be allowed to prevent this gain by obstructing or rendering ineffective the scheme for the larger area. The point is that if all the towns, which constitute the "fat" districts, are cut out of these schemes, leaving only the "lean" rural districts for the large-area companies, there can be little or no hope of financial success. In order to obtain, therefore, the greatest good for the greatest number, the larger authority ought to be allowed wherever possible to prevail over the smaller municipalities opposing it, especially when we consider that this does not entail an injustice to these municipalities, but only a slight narrowing of the field of municipal enterprise.

It remains to consider what is, perhaps, the most remarkable feature in recent electrical progress—the development of the electric tramway. The law relating to this branch of the subject is, unfortunately, still more unsatisfactory than that dealing with lighting and power, for the controlling Act is still the Tramways Act of 1870, which was passed before electric traction was introduced, and was intended to deal simply with the ordinary horse-tramway. The defects of that Act are too well known to require mention here; the objectionable veto given to the local authorities has once more been sufficient in itself to retard progress to an extraordinary degree. The fact that in the last few years electric tramways have developed so much in this country is not due to the existence of the Tramways Act, but principally to the fact that it was found possible to evade that Act to a considerable extent by promoting these concerns under the Light Railways Act, 1896—an Act which was really intended for another class of undertaking altogether. That Act has proved beneficial to a high degree, as it lowers the cost and simplifies the procedure when a tramway scheme is promoted; but in the years during which it has been in operation, various defects have been discovered, and attempts have from time to time been made to have them remedied. My predecessor, Mr. Swinburne, pointed out these defects to the President of the Board of Trade when our deputation waited upon that Minister last year, and here, again, we were promised a measure to remedy them. A Bill *was* introduced this year, but it was unsatisfactory in the extreme, as it made no attempt to deal with the whole subject, but merely tinkered at one or two details; and we cannot regret, therefore, that it made no progress. The Board of Trade had previously appointed a Committee to consider what amendments of the Act of 1896 were desirable, and as the President of the Board of Trade told our deputation that a report had been received from that Committee, we naturally expected that the new Bill would deal comprehensively with the subject, but in this we have been disappointed. The old Tramways Act ought to be repealed, and replaced by a measure suitable for modern needs. Under the Light Railways Act the powers of the Commissioners might with great advantage be extended. At present they are hampered by the feeling that, if not bound by the letter of the Tramways Act, they must, as far as possible, respect its spirit; and hence the absence of consents from local authorities has more weight than is proper. In cases where a light railway scheme is likely to compete with an existing railway company, the provision that the promoters must proceed by private Bill, and not by an inquiry before the Light

Railway Commissioners, also militates considerably against the usefulness of the Light Railways Act by curtailing the powers of the Commissioners; and this restriction ought to receive attention in any amending measure.

These are but a few of the numerous points in the present law which call for attention. The whole of our electrical legislation is in urgent need of reform; and after so many promises have been made, it will be very regrettable if nothing is done to remove the existing defects.

While the electric light and power undertakings have obtained but little legislation in their favour, it is a relief to see that Parliament has granted railway companies certain advantages. By the Railways (Electrical Power) Act, which received the Royal assent on August 14th last, existing railway companies desiring to convert any of their lines to electric traction, are enabled to obtain sufficient powers for so doing by means of an order of the Board of Trade. They may become interested in power companies, and may take from them electrical energy for the supply of their main or branch lines.

In spite of the legal impediments referred to, it will be found on investigation that substantial progress has been made in Great Britain in the utilisation of the electric current for both light and power purposes.

Exclusive of traction motors, in March of this year, lamps and motors equivalent to over 14,000,000 8-c.p. lamps were connected to the mains of public electricity supply undertakings, the metropolis being represented to the extent of about 5,000,000. There were about 300 towns enjoying the advantage of an electricity supply, this number including, with two exceptions, all the towns whose population exceeds 100,000. The exceptions were Tottenham and the Rhondda district, which did not seem anxious to be alongside of their 38 fellows. It appears that, at this period, exclusive of power companies, the public supply stations had motors amounting to 55,000 H.P. connected to their mains.

Municipal undertakings own generating plant of a rated capacity of 320,000 KW., and private undertakings are represented by 160,000. In the metropolis the companies are proprietors of about 100,000 KW., whereas the public bodies are responsible for approximately 28,000. The pre-eminence of the companies in London is due to the fact that they acted as pioneers and were first in the field. The average rated capacity of a British station appears to be about 1,400 KW. It is to be remarked that, while in the provinces the average municipal station has a capacity of nearly three times that of a company station, in the metropolis the ratio is reversed. Again, the average metropolitan company has, approximately, 10 times the plant capacity of the average provincial company.

It is interesting in this investigation to note that modern tendencies in this country are decidedly in favour of the direct current system with a three-wire distribution; the number of direct current undertakings increased from 139 in 1901 to 214 in 1902, and 260 in 1903. For these three years the alternating current stations numbered 67, 68 and 69 respectively. There are now established in Great Britain 13 two-phase and five three-phase stations, exclusive of power transmission stations. In 29 cases supply is given on two or even more systems. Many of the alternating current stations have taken up the supply of direct current, others have added two-phase or three-phase supply to their single-phase service, or have changed over completely to one of these. The direct current system appears to be in no immediate danger of supersession, in part owing to the raising of the voltage, and the consequent possible extension of the service area. The number of voltages in use is somewhat confusing, and presents to the Standards Committee a difficult problem to solve. These voltages now amount to about 10, and out of 289 examples of pressures nearly one-third are declared at 230, more than one-sixth are given as 220, while voltages of 240, 200 and 100 claim about one-eighth each. There are between 50 and 60 stations which revel in more than one declared pressure. The extent to which the change from one voltage to another has taken place may be judged by the fact that in 234 cases the pressure is upwards of 200 volts; 64 supply current both above and below 200, and there are only 29 whose supply is entirely under 200 volts.

Although at the present moment the efficiency of carbon glow lamps, and, in certain cases, of arc lamps, is not so great at the higher voltages, yet it cannot be gainsaid that the change of voltage has been a beneficial one both for the supplier and consumer. The supplier has benefited through a more profitable use of his current conductors; this benefit has considerably more than outweighed the expenditure in other directions that the change entailed. In many cases one of the large expenditures must have been in the purchase of storage batteries, for it appears that out of 330 stations, no fewer than 240 use these batteries to a greater or less extent. The only drawback to the change would appear to exist in the case of small motors,

Some remarks on the methods of charging for current could be made, but I limit myself to pointing out that the number of lighting undertakings in which the maximum-demand system is employed alone is now 104 as compared with 114 in 1902, or, say, 31½ per cent. instead of 40 per cent. of the totals of the respective years. The maximum-demand system in conjunction with one or more other systems is used in 74 cases, as against 38 in 1902, or, say, 22½ per cent. as compared with 13½ per cent. A simple uniform-rate gives the corresponding figures of 70 and 63, representing 21½ per cent. against 22 per cent. I regret I have not been able to collect information with regard to private installations in Great Britain, which would prove sufficiently comprehensive. I have therefore decided to leave this portion of the subject alone.

There is still room for improvement in the carbon glow lamps. I am given to understand that 16-c.p. lamps for 200 volts and upwards, with a life of 1,000 hours at an average consumption per candle of even 4 watts, can hardly be obtained as a commercial article. The production of the Nernst lamp seems to be improving, and its employment in a large number of towns for street lighting, and in many private installations, will enable people to thoroughly appreciate its merits and utility. I find that the most recently introduced pattern gives three-quarters of a candle per watt when new. Nernst lamps are used by about 1,000 supply companies in the United States, the Hartford (Connecticut) Co. alone employing about 4,000. In many cases these lamps are maintained by the supply company without extra charge, or at a nominal cost. The Osmium lamp of Auer von Welsbach is well spoken of for low voltages in some quarters. Twenty-five to 30-volt lamps have been made which show little diminution in light-giving power after 800 to 1,000 hours burning. Apparently they absorb about 1·5 watts per candle, but are expensive to purchase. We shall doubtless hear more of the mercury vapour lamp associated with the name of Mr. Cooper Hewitt.

While, with alternating-current work, the tendency is always to simplify the switch-gear to the utmost, this does not seem to be universally the case in direct-current practice, at any rate, in the smaller public supply stations. Some of these have elaborate plug-boards, numerous bus-bars, expensive battery regulators, and all sorts of alternative ways of doing the same thing. In many cases where these complications do not exist, not only the comfort of the staff but the efficiency of the service are greatly increased. It appears to be forgotten that everything tending to simplicity has a beauty of its own which no complication can ever rival. In spite of the absence of any notable development in switch-gear, a very high standard has been attained by British designers, especially in heavy power and lighting work with alternating currents at high pressure. Following a totally different line from the Continental and American practice, our engineers have evolved apparatus which is at the same time safe, simple and reliable, while occupying a minimum of space.

In the early days of the electrical industry when the range of possible distribution of current was restricted, the engineer had to seek a site for his generating station in crowded and expensive districts. To economise space he employed high-speed reciprocating engines and water-tube boilers. At that period he could doubtless do this with advantage, as the generator units in use were, comparatively speaking, small. To-day the units are larger and the range of possible distribution is increased. It is not, therefore, so necessary to follow the old practice, and in many cases to do so is inadvisable.

Among the remarkable things of the year may be mentioned as in course of construction, four turbo-generators of the Parsons type, each rated at 5,500 to 8,280 KW., and occupying a space measuring only 51¼ × 14 × 12 ft. A 6,500 KW. turbo-generating set is being built by Brown, Boveri & Co. which measures 59 × 10 × 10 ft. A Curtis turbine of 5,000 KW. is running in Chicago; this turbine is a combination of the Parsons and De Laval systems and is arranged with a vertical shaft, a somewhat inadvisable design. In shape it is cylindrical, and, including turbine and generator, stands 25 ft. high with a diameter of 14 ft. It may be interesting to note that there are over half a million H.P. of turbines in use or on order, and 24 stations in this country use the turbine more or less. While referring to large units, it may be of value to state that the Société Cockerill of Seraing is expected to show at the St. Louis Exhibition next year, a gas engine of 3,000 H.P.; this engine will have two cylinders, each of 51 in. diameter, and will run at 85 revolutions per minute. It is said that the Gasmotoren Fabrik Deutz is designing a 6,000 H.P. engine.

With relation to electric driving in factories and ships, we all remember the excellent papers read before this Institution by Mr. Williamson and by the late Mr. C. E. Groves. The contribution of the latter was especially interesting to me, as it showed in a striking manner the progress in the employment of the electric current on shipboard from the time of the Silvertown Co.'s installation on their cable steamer *Dacia*, in 1879, down to the huge developments already reached at the time the paper was read.

Among the recent varied uses to which electromotors can be put may be mentioned gold mining at the Klondike, where they are employed in dredging, washing and conveying the material to the tip. Another instance is the driving of a rolling mill, where a 400-H.P. motor is coupled direct to the rolls. In a large plate-glass works in America there are four generating sets of 4,000 KW. each and one set of 350 KW.; there are also 20 motors of 450 H.P. each and 20 of 200 H.P. The three-phase system is in use at 5,800 volts with frequencies of 40 and 25 cycles per second. A large colliery in the same country has plant of 2,900 KW., the installation comprising 44 mining locomotives and 75 miles of underground trolley wire; the power is transmitted at 5,600 volts, three-phase, 25 cycles per second, but is converted for use at 275 volts. At the Carnegie Works electricity is used for almost everything requiring power, and it is stated that in the Homestead Steel Works, of Pennsylvania, by the aid of electricity 4,000 men make as much steel as is made at Krupp's with 15,000 men.

Since the establishing of the Portrush electric tramway in 1883, the electrical engineer has encroached on the field of the tramway engineer, and consequently the purely tramway work, as apart from the electrical work, has often shown the mark of the active, clever, but untrained mind, impossible curves and grades being attempted, and unnecessarily expensive work being done. There has been some advantage in this, no doubt, as the experience gained by these works, although expensive, has tended to improvements in practice. There is an American manner in this mode of procedure which leads to a free use of the scrap heap. The individual suffers, but the community eventually gains by the survival of the fittest. It is, I suppose, a rule which applies, and must apply, to all young nations and industries. The rough and tumble while it lasts is interesting and exciting, and doubtless drives the workers to put their best foot foremost. The golden rule, "Be

sure you are right, and go ahead," is the best to follow but it often happens that one dies and is taken from the arena before even the first part of the rule is complied with. On the whole, therefore, it is perhaps as well that chance should be allowed to play its part, and that activity and energy should not be troubled with a too severe bearing-rein. The rule before cited should probably be modified in the manner of the saying of the northern farmer to his son, and should read, "Be sure you are right and go ahead, but go ahead." I think this has been the motto that has been adopted by electrical engineers since 1877, with the much desired effect that sufficient improvement has been made to enable the electrical barque of this country to be steered into still water for a time. This happy condition does not, I believe, exist in Germany or America, where apparently there are "more heads to be broke." We have been toiling up a steep hill for many years, and the time has now arrived when we should stop and survey the landscape as a whole, instead of narrowing our view to the particular point towards which we happen at the moment to be ascending. Already many of the paymasters are questioning the scrap-heap theory, as they know by experience that this is often evolved from nothing but a craving for change, and a want of appreciation of the true value of money on the part of their advisers. I make these remarks with no desire to convey the idea that work in this country is not carried out conscientiously and well, but rather with the view of suggesting a curbing of the expenditure of money which produces a semblance for the moment of unbounded prosperity, while in reality it only means riding full gallop for a fall. If the fall should occur, the many men who are entering our ranks every day and swelling our numbers, will find their prospects blighted owing to a disturbance of the trust which is placed in the electrical engineers of to-day by those who supply the sinews of war. I, therefore, think it incumbent on every electrical engineer to carefully weigh every recommendation he may make, not from the point of view of immediate, but rather from that of ultimate efficiency, and to deal with every possible factor in drawing his estimates. The papers read, and the discussions which take place in this hall, and in the meeting places of our local sections, tend to this end.

(*To be continued.*)

OUR LEGAL QUERY COLUMN.

[*Questions addressed to the Editors for insertion in this column should be written on one side of the paper. Free use of fictitious names, &c., may be made. Answers are furnished by a duly qualified lawyer, but the Editors cannot undertake to be responsible for the accuracy of the views which he may express.*]

"Bute" writes:—"I should like to take advantage of your legal column to ask if it is legal for any company supplying electrical energy, to use premiums obtained on the issue of shares for any other purpose than a reserve fund."

*** Without having an opportunity of consulting the memorandum and articles of association of the company referred to by our correspondent, it is difficult to answer his query. It is no doubt usual for the premiums paid upon shares issued at a premium to be devoted to the reserve fund, but unless the company are bound by a clause to this effect in their memorandum and articles, there seems to be no reason why a premium, which is really a profit on the issue of shares, should not be devoted to any purpose. Such profit is certainly not capital, for it need never be repaid.

NEW PATENTS APPLIED FOR, 1903.

Compiled expressly for this Journal by W. P. Thompson & Co., Electrical Patent Agents, 322, High Holborn, London, W.C., and at Liverpool, to whom all inquiries should be addressed.

23,686. "An improved fog or danger signal for steam or electric railways." A. Johnson. November 2nd.

23,712. "Improvements in the manufacturing of dry batteries." H. Nehmer. November 2nd.

23,715. "Improved apparatus for operating railway signals and points by electricity." E. M. T. Boddam. November 2nd.

23,716. "Improved electric interlocking apparatus for operating electrically-worked signals and points." E. M. T. Boddam. November 2nd.

23,717. "Improved method of operating electrically-worked signals by means of contacts made by moving trains." E. M. T. Boddam. November 2nd.

23,743. "Improvements in electrical indicators." L. P. C. Hodson. November 2nd.

23,760. "Improvements in or relating to electric signalling apparatus for railways." E. Danneels. November 2nd. (Complete.)

23,767. "Improvements in galvanic batteries." The Halsey Electric Generator Co., Ltd. (The Halsey Electric Generator Co., United States.) November 2nd.

23,780. "Insulated cam for contact breaker of internal combustion engines." H. A. Meredith. November 3rd.

23,838. "Improvements in electrical resistances." P. M. A. Matthews. November 3rd.

23,851. "Improvements in electric cranes." Stothert & Pitt, Ltd., and W. Pitt. November 3rd.

23,853. "Mercury electrolytic apparatus specially applicable to electric meters and electric switches." E. du Bois and The Reason Manufacturing Co., Ltd. November 3rd.

23,854 "Method of effecting a phase-shift of 90° or more between the pressure and the field in the shunt circuit of alternating current meters." O. Imray. (Siemens-Schuckert Werke G. m.b. H. Germany.) November 3rd. (Complete.)

23,862. "Improvements in electric fog recording and like apparatus." H. von Kohler. November 3rd. (Complete.)

23,863. "Improvements relating to electric distribution systems." J. H. Hallberg. November 3rd. (Complete.)

23,915. "Electric light adaptor for reading lamps." W. L. Miller. November 4th.

23,928. "Improved means applicable for use in automatically cutting out resistance in alternating current electro-motors." J. Bush. November 4th.

23,956. "Improvements in connection with vacuum brake apparatus for electrical and other railways." J. Gresham and H. Albert. November 4th.

23,961. "Improvements in meters for use in connection with electric heating systems, and other systems or apparatus consuming energy, or for recording periods of time." E. Cunliffe-Owen, E. W. J. Macdonald and A. F. Harmer. November 4th.

23,978. "Improvements in and relating to overhead electric current conductors." E. Giraud. (Date applied for under Patents Act, 1901, November 5th, 1902, being date of application in France.) November 4th. (Complete.)

23,987. "Improved electric ignition devices for gas engines, oil engines and petroleum motors." E. de la Roche Rendell and G. A. Minshall. November 5th.

23,988. "Improvements in the means for electrically-operating switches and other apparatus." H. J. Fuller. November 5th.

24,023. "Improvements in or relating to electric arc lamps or mercury vapour lamps, or the like." C. O. Bastian. November 5th.

24,025. "Improvements in printing telegraph receivers." J. D. White. November 5th.

24,055. "Improvements in apparatus applicable for use in connection with telephones and other purposes." J. A. Gamble. November 5th.

24,083. "Improvements in electrical apparatus used in propelling autocars and other vehicles, launches, and the like." E. S. G. Rees. November 6th.

24,098. "An apparatus for limiting electric currents." J. Azabola. November 6th. (Complete.)

24,102. "Improvements relating to electric ignition apparatus for motor-cars, motor-cycles, and the like." W. W. G. Webb, J. Hall, C. H. Offord and A. C. Barfield. November 6th.

24,116. "Improvements in electrical machines." B. C. Molloy. November 6th.

24,127. "Improvements in electric bath tubs and in electrodes therefor." J. Zwiebel. November 6th. (Complete.)

24,129. "Improvements in the structure of alternators." A. P. Zani. November 6th.

24,130. "The U.K.I. electric dental and manicure engine." F. W. Gould. November 6th.

24,144. "Improvements in electrically-controlled valves." O. Junggeren. (Date applied for under Patents Act, 1901, November 15th, 1902, being date of application in United States.) November 6th. (Complete.)

24,200. "A portable electric fan." M. Margowski. (R. Klemm, Germany.) November 7th.

24,212. "New or improved means for controlling arc lamps." H. J. Haddan. (The firm trading as S. Zielenziger, Germany.) November 7th. (Complete.)

24,216. "Improvements in cut-outs having two or more fuses." T. H. Marsh and H. H. S. Marsh. November 7th.

24,217. "Improvements in and relating to automatic fuse cut-outs and cut-ins." T. H. Marsh and H. H. S. Marsh. November 7th.

24,220. "Improvements in apparatus for lighting gas lamps by electricity." O. Gergacsevics. November 7th.

24,223. "A device constituting a combination of an electric lamp with a lighter for cigars and the like." J. E. Waller. November 7th.

24,235. "Improvements in electric arc lamps." W. J. Davy. November 7th.

PUBLISHED SPECIFICATIONS.

Copies of any of these Specifications may be obtained of Messrs. W. P. Thompson and Co., 322, High Holborn, W.C., and at Liverpool, price, post free, 9d. (in stamps).

1903.

Brake Apparatus of Electric Railway and Tramway Vehicles. The Johnson-Lundell Electric Traction Co., Ltd. (J. G. V. Lang, Germany.) 2,564. February 3rd.

Transmission Systems. E. E. Clement. 2,598. February 3rd.

Switch-operating Devices for Conduit Systems of Electric Tramways and Railways. J. D. Edwards. 2,644. February 4th.

Ratchet-operated Electric Switches. W. Kingsland. 2,774. February 5th.

Speed Regulation of Continuous Current Electric Motors. E. S. W. Moore and T. L. Boyden. 2,980. February 7th.

Telephone Apparatus. R. B. Ransford. (The Kellogg Switchboard and Supply Co., United States.) 3,072. February 9th.

Telephone Apparatus. R. B. Ransford. (The Kellogg Switchboard and Supply Co., United States.) 3,073. February 9th.

Telephone Apparatus. R. B. Ransford. (The Kellogg Switchboard and Supply Co., United States.) 3,074. February 9th.

Electro-pneumatic Valves for Pneumatic Railway Signalling Systems E. C. Irving and J. P. O'Donnell. 3,078. February 9th.

Coin-freed Apparatus. F. H. Urry and W. Haydon. 3,172. February 10th.

Telegraphy. R. B. Ransford. (The Delaney Foreign Co., United States.) 3,183. February 10th.

Arc Lamps. J. A. Rignon. 3,198. February 10th.

Electricity Meter. Theiler & Co. 3,274. (Date applied for under Patents Act, 1901, February 15th, 1902, being date of application in Switzerland.) February 11th.

Switch or Circuit Breaker. F. Testor. 3,453. February 13th.

Wireless and Other Electric Apparatus Acting on Typewriters. G. Musso. 3,695. February 17th.

Arc Lamps Electrodes. M. Lilienfeld. 3,698. February 17th.

Guards for Trolleys or Electric Collectors. C. O. Prince. 3,745. (Date applied for under Patents Act, 1901, September 2nd, being date of application in United States.) February 17th.

Ceramic Cover for Electric Cables. C. Bodniec. 3,845. February 18th.

Releasing Automatic Mechanical Devices and the Like by Coin Freed Wirelessly Transmitted Electric Waves. C. G. Smith and T. Harrison. 3,921. February 19th.

Motors for Electric Vehicles. C. de Kando. 3,989. February 19th.

Electric Batteries. W. R. Goddard. 4,039. February 20th.

Electro-Magnetic Safety Cut-outs. P. Jensen. (Dr. G. Langbien & Co. Germany.) 4,083. February 20th.

Lamp-Holders and the Like. H. Hirst and T. H. Bacon. 4,145. February 21st.

Electric Incandescent Lamps. C. C. Regnart. 14,754. July 2nd.